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RUN REPORTS: CO_2 ACCEPTOR PROCESS GASIFICATION PILOT PLANT

Final Report, Volume 8, Book 4 of 6, Runs 28–36
August 1975–May 1976

Work Performed Under Contract No. EX-76-C-01-1734

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RUN REPORTS

CO_2 ACCEPTOR PROCESS GASIFICATION PILOT PLANT

FINAL REPORT, VOLUME 8
BOOK 4 OF 6, RUNS 28 - 36
PERIOD: AUGUST 1975 - MAY 1976

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FOREWORD

The reports contained in this document were prepared jointly by Conoco Coal Development Company and Stearns-Roger, Incorporated, as partial fulfillment of the Department of Energy contract (EX-76-C-01-1734) for the development of CO_2 Acceptor Gasification Process. Each report normally covers the operation of the CO_2 Acceptor Process Pilot Plant for a single run. Some runs, however, have several parts (A, B, C, etc.) and occasionally two or more runs have been grouped together in a single report.

The reports are informal data reports which were written shortly after the completion of the respective runs. The reports serve the purpose of recording the objectives, accomplishments, and problems encountered during the pilot plant operations. Operating data are also often presented. However, these data are, for the most part, presented as a matter of record since the inclusion of heat and material balances and the analysis of the data was not part of the scope of the run reports.

Prior to Run 16, no periods of truly steady-state integrated plant operation were obtained for which heat and material balances can be calculated. The development of a reliable, standardized startup procedure, the solving of process and especially mechanical equipment problems, were the primary concerns during these early runs.

Much needed process data at steady-state conditions were gathered during the later runs. Detailed heat and material balances for selected runs are presented in Volume 12 of the Final Report. Some discrepancies will be found between the data presented in the run reports and the heat and material balance results. For example, the acceptor circulation and gasifier vent rate presented in many of the run reports do not agree with the heat and material balance values.

The run report acceptor circulation rates are based upon the acceptor lift line pressure drop and are considered to be only an approximation of the actual acceptor circulation rate. The pressure drop derived circulation rate served as a guide to the plant operators and provided trend information. Because of the severe temperature and pressure conditions in the process, the acceptor circulation and also the fuel char rates cannot be directly measured. These rates can only be accurately determined via detailed heat and material balance calculations. A mathematical model of the process, which is embodied in the form of a computer program was therefore developed. The model values for the acceptor circulation and the fuel char rates are presented in the detailed heat and material balances. These rates are considered to be correct.

The measured gasifier vent rates (product gas rates) contained in the run reports are generally lower, and often much lower, than the mathematical model values. There are several reasons for this. First, process flow measuring instrumentation was often fouled by the small amounts of char fines and liquid water contained in the vent gases. Secondly, undetected process leaks from valve packings and from vessel and piping flanges represent sizable losses in the available vent gas quantity to be measured. The actual vent gas from the gasifier is better represented by the mathematical model value than by the measured value.

The above examples point out that consideration must be given and judgements made concerning the use of certain process data. The philosophy with respect to data analysis, has been to use the mathematical model to match as much as possible the measured process data. Differences between the model results and the measured data are resolved by the reexamination of instrument records and the pilot plant logs or by modifying the model where necessary.

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RUN 28

AUGUST 26 TO SEPTEMBER 27, 1975

CO_2 ACCEPTOR PROCESS GASIFICATION

PILOT PLANT

RAPID CITY, SOUTH DAKOTA

1 SUMMARY

Run 28, which was conducted in two parts, was the most successful run to date in demonstrating the operability of the CO_2 Acceptor Process. The run featured the use of a locally quarried acceptor, Minnekahta limestone, and Velva lignite feedstock. The major accomplishments were: (1) the successful demonstration of plant operability using limestone acceptor; (2) the demonstration that the use of pure steam to fluidize the recarbonated limestone did not adversely affect plant operation in any way; and (3) the acquisition of steady-state operating data during balance periods.

The initial run in the series, Run 28A (August 26 to September 1, 1975) ended prematurely due to a gasifier boot upset. The origin of the upset was solely mechanical in nature and was due to the failure of a purge gas valve which keeps a positive gas flow between the spent acceptor withdrawal hopper, F-213, and the gasifier boot.

The run was not of sufficient length to achieve steady-state conditions for which heat and material balance data could be obtained. However, the startup was smooth, and operations had progressed past the stage at which all the air was removed from the gasifier. Approximately 50 percent of the original dead-burned dolomite had been replaced with fresh limestone acceptor prior to the shutdown. The limestone activity behaved as expected and was equivalent to that of dolomite when based upon the amount of CO_2 absorbed per unit mass of stone.

For Run 28B (September 12 to September 27, 1975) two balance periods of 33 and 40 hours respectively were obtained. This marked a milestone for integrated operation of the pilot plant since for the first time truly steady-state (i.e., nonchanging) conditions were obtained.

The pilot plant also demonstrated a remarkable resilience to major gasifier upsets. The plant operation was fully recovered following an upset in which the gasifier fluidizing steam flow was lost due to a boiler shutdown. A second full recovery was made following a gasifier boot upset which was caused by the operation of the spent acceptor withdrawal hopper. The run was finally terminated after a third upset which caused the recarbonated acceptor standleg to plug. The upset resulted from the after effects of plugging both the recarbonated acceptor standleg sample station and the balance gas line.

2 TEST DATA

Run 28 data are presented graphically and/or tabularly at the end of this run report. These figures and tables include:

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3 SIGNIFICANT EVENTS AND OBSERVATIONS

3.1 HISTORY OF RUNS 28A AND 28B

3.1.1 Objectives

The goals for both Run 28A and Run 28B were:

(1) To demonstrate plant operability using a new acceptor feedstock (Minnekahta limestone).

(2) To demonstrate that pure steam could be used to fluidize the recarbonated acceptor collected in the gasifier boot.

(3) To achieve long duration steady-state balance periods for which heat and material balance data could be collected.

3.1.2 Accomplishments

Run 28A

Operated pilot plant in an integrated manner and replaced a sufficient amount of the initial dead-burned dolomite inventory with fresh limestone to allow removal of all air supplied to the gasifier.

Run 28B

(1) Demonstrated the operability of the CO_2 Acceptor Process using Minnekahta limestone and Velva lignite as feedstocks.

(2) Demonstrated the feasibility of using pure steam to fluidize the collected acceptor in the gasifier boot.

(3) Achieved truly steady-state operating conditions for long periods in which the only inputs to the gasifier were calcined acceptor, lignite and steam.

(4) Successfully controlled the concentration of intermediate fines in the gasifier's fluidized char bed.

(5) Successfully recovered plant operation after two severe process upsets.

3.1.3 Termination Causes

Run 28A

This run ended due to a gasifier boot upset caused by the operation of the spent acceptor dump hopper, F-213. The

stem on the purge valve, which supplies gas to maintain a positive pressure between F-213 and the gasifier, vibrated loose from the valve actuator. This resulted in the valve remaining in the closed position. Due to leaks in the F-213 system, gasifier boot steam was then drawn into the hopper. Boot fluidization was lost and the acceptor level rose into the transition section. The recarbonated acceptor standleg and the line between the boot and the dump hopper, F-213, then plugged. The run was terminated.

Run 28B

The run ended as a result of a gasifier boot upset which was initiated by the plugging of both the recarbonated acceptor sample station, S-10, and the balance gas line to the recarbonated acceptor standleg, CD-204. During this period steam flushed down CD-204 and plugged the line causing the acceptor level to rise into the gasifier transition section.

3.1.4 Mechanical Problems

Run 28A

(1) Feeding of auxiliary fuel char could not be readily confirmed during the run. Prior to Run 28B, a thermocouple was installed in the char transfer line, CO-204, at the point at which the auxiliary fuel combines with the char withdrawn from the gasifier. This proved to be an effective means of determining the existence of the auxiliary fuel feed.

(2) To provide additional instrumentation for the gasifier internal cyclone, pressure taps were installed on the cyclone dipleg prior to Run 28A. These taps proved to be useless since they continually plugged.

Run 28B

(1) Steam flow to the gasifier was totally lost when the plant boiler shut down. The shutdown was caused by a boiler blowdown operation which resulted in a false low water instrument signal.

(2) The first steady-state balance period ended due to a gasifier boot upset in which the acceptor transfer through CD-204 ceased and the acceptor level rose into the gasifier transition section. The upset was caused

by the operation of the spent acceptor withdrawal hopper, F- 213. Leaks in the hopper system appeared to periodically rob the gasifier of part of the boot fluidizing gas.

3.1.5 Process Problems

During both runs the acceptor lift gas heater tube metal continued to deteriorate.

3.2 CHRONOLOGY OF OPERATIONS

3.2.1 Run 28A

Date	Time	Hours Counting	Description
8/26	1652		Started pressuring up the system with air.
"	1800		Holding the system pressure at 60 PSIG in order to repair some small leaks.
"	1835		Started depressuring the system in order to repair the leaks.
"	1910		System depressured.
"	1948		Pressuring up the unit with air again.
"	2045		System up to pressure. Started grinding lignite for the preheater.
"	2100		Stopped grinding lignite due to problems with the roller mill.
"	2230		Started depressuring the system in order to clean out gasifier back pressure control valve, PT-2022.
8/27	0045		System back up to pressure.
"	0100		Started static pressure test.
"	0200		Finished the static pressure test. Started all recycle gas compressors.
"	0225		"A" and "B" gas dryers placed on line. Lit all system heaters.
"	0450		System at 250°F and starting the first holding period. Started the differential pressure tests on the system heaters.
"	0525		Finished the differential pressure tests on the heaters.
"	0830		Started grinding lignite for the preheater.
"	1100		Finished the temperature holding period to cure refractory and started raising the system temperature at 50°F/HR.
"	1400		Shut down J-202, main air compressor, for maintenance.
"	1530		J-202 back on line.
"	1616		Shut down the process heaters and started depressuring the system in order to repair LCV-2002, char transfer control valve.

Date	Time	Hours Counting	Description
8/27	1745		System depressured.
"	2210		Started repressuring the system.
			NOTE: The liner inside the CO-202 had to be ground down and rewelded.
			Lit the process heaters.
8/28	0400		System temperature at 700°F, started the second holding period for refractory cure.
"	0800		Finished the temperature holding period and began raising system temperature at 100°F/HR.
"	1045		Stopped grinding lignite after discovering limestone going to FA-102, lignite storage tank. Maintenance began taking lines apart in order to empty the roller mill, surge bin and storage bin.
"	1200		Started CO_2 addition to the gasifier boot flow for test purposes.
"	1300		Shut down J-309, char lift line gas compressor for maintenance.
"	1515		Placed J-309 back on line.
"	1600		Finished CO_2 gas flow test, removed CO_2 from the gasifier boot flow.
"	1610		Started dead-burned dolomite addition to the gasifier via F-204A, fresh lignite feed lockhopper.
"	1823		Transferred a batch of dead-burned dolomite from the gasifier via LCV-2003, gasifier boot acceptor level control valve.
"	1856		Started filling the regenerator with dead-burned dolomite via F-206B, fresh acceptor feed lockhopper.
8/29	0420		Initiated solids circulation.
"	0640		Started solids circulation test.
"	0800		Emptied FA-102 of limestone-lignite mixture, began closing 100 area up.
"	0810		Finished solids circulation test.
"	0822		Stopped solids circulation in preparation for gas flow tests. Placed the zinc oxide towers on line.
"	0845		Started the gas flow tests.
"	1017		Finished the gas flow tests.
"	1023		Resumed solids circulation.
"	1220		Maintenance finished with the 100 area and starting to grind char.
"	1340		Started dead-burned dolomite makeup to the regenerator via F-206B. Finished grinding char.

Date	Time	Hours Counting	Description
8/29	1520		Started char addition to the gasifier via F-204B. Finished grinding char.
"	1750		Initiated air addition to the gasifier side flow.
"	1805		Increased steam flow to the gasifier side flow.
"	1930		Introduced steam into the gasifier boot.
"	2040		Started grinding char again.
"	2205		Started auxiliary char feed to the regenerator at minimum RPM.
"	2210		Started char transfer. F-213, purged acceptor lockhopper, out of service due to plugged inlet and drain lines.
"	2235		F-213 lines cleared and back in service.
"	2300		Char transfer erratic. NOTE: Closed LCV-2002, took char removal system out of service, depressured removal lockhopper, and then opened to system. Char transfer improved.
8/30	0100	0	Regenerator at 1800°F.
"	0300		Stopped dead-burned dolomite makeup to the regenerator for 10 minutes. NOTE: F-206B had to be depressured in order to fill F-206A due to a leaking ball valve between the two vessels.
"	0310		Switched from grinding char to grinding lignite.
"	0500		Balance gas line to dPRC-2037 plugged.
"	0730		Switched from grinding lignite to grinding char.
"	0800		Sharted lignite addition to the gasifier via F-204A.
"	0904		Stopped fresh dead-burned dolomite makeup to the gasifier in order to repair the ball valve between F-206A and B lockhoppers.
"	0945		Resumed fresh dead-burned dolomite makeup.
"	1000		Finished grinding char and started grinding lignite.
"	1140		Cleared the balance gas line for dPRC-2037.
"	1320		Finished grinding lignite.
"	1615		Char transfer becoming erratic.
"	1830		Started grinding lignite.
"	2250		Stopped grinding lignite, preheater full.
"	2300		Started feeding fresh limestone to the regenerator via F-206B. Char transfer back in control. NOTE: Discovered that F-226B, auxiliary char feed lockhopper, was empty without an alarm. Had to depressure F-226B in order to allow material in F-226A to flow into the lower vessel.

Date	Time	Hours Counting	Description
8/31	0030	26	Started grinding lignite.
"	0430		Removed "B" ZnO tower from service in order to recharge the catalyst.
"	1015		Removed all recycle gas from the regenerator side flow.
"	1145		Finished grinding lignite.
"	1330		Started grinding lignite.
"	2005		Finished grinding lignite.
"	2050		J-201B, gasifier recycle gas compressor, shut down, no longer needed.
9/1	0010		Resumed lignite grinding.
"	1100	58	Finished grinding lignite.
"	1103		All air out of the gasifier side flow.
"	1200		Introduced CO_2 gas into the gasifier boot flow.
"	1340		Started grinding lignite.
"	1622	63.37	Experienced upset in the gasifier boot. Lost acceptor transfer to F-213 and to the regenerator. Attempts to regain any transfer failed.
"	1900		Stopped grinding lignite.
"	2000		Initiated shutdown procedures.
9/2	0345		System depressured.

3.2.2 Run 28B

9/12	1010		Started pressuring up the system with J-309, char lift gas compressor.
"	1045		J-202, main air compressor, placed on line, J-309 shut down.
"	1100		System up to pressure. Started static pressure test.
"	1230		Finished static pressure test.
"	1250		J-309 placed back on line.
"	1310		Started all recycle gas compressors and placed on line.
"	1320		Lit all process heaters except for B-205, acceptor lift gas heater.
"	1325		"A" and "B" gas dryers placed on line. Lit B-205 heater, electricians repaired the ignitor.
"	1630		System at 250°F, started six hour holding period per refractory cure writeup.
"	1640		Started grinding lignite for the preheater.
"	1730		Started heater differential pressure tests.

Date	Time	Hours Counting	Description
9/12	2000		Finished heater differential pressure tests.
"	2230		Finished holding period on the system temperature and started raising the temperature at 50°F/HR.
9/13	0730		Started second temperature holding period of the refractory cure procedure.
"	0745		Stopped grinding lignite to permit maintenance to work on the 100 area.
"	1100		Maintenance finished with the 100 area and started grinding char.
"	1130		Finished four hour holding period, began raising system temperature at 100°F/HR.
"	1330		Finished grinding char, shut down the 100 area.
"	1900		Started adding dead-burned dolomite to the gasifier via F-204A, lignite feed lockhopper.
"	2135		Transferred a batch of dead-burned dolomite from the gasifier to the regenerator.
"	2155		Started adding dead-burned dolomite to the regenerator via F-206, fresh dolomite lockhopper.
9/14	0035		Started grinding char to tote bins.
"	0415		Finished grinding char, shut down 100 area.
"	0710		Established acceptor circulation.
"	0845		Started the solids circulation tests.
"	1030		Completed solids circulation tests. Stopped solids circulation and started lift line gas flow tests.
"	1045		Finished lift line gas flow tests. Started solids circulation. Started calibration tests for XCV-2073, purged dolomite control valve.
"	1135		Started grinding char.
"	1530		Finished grinding char.
"	1600		ZnO system placed on line.
"	1645		Steam introduced into the gasifier side flow.
"	1800		Finished calibration tests for XCV-2073.
"	1835		Started char addition to the gasifier via F-204A.
"	2130		Gasifier char bed filled to level of dPR-2094. Started air addition to the gasifier side flow.
"	2345		Started grinding char.
"	2400		Started steam addition to the gasifier boot flow.
9/15	0150		Started auxiliary char feed to the regenerator.
"	0230		Initiated char transfer.
"	0240		Finished grinding char, started grinding lignite.

Date	Time	Hours Counting	Description
9/15	0615		Started auxiliary char and established char transfer.
"	0700	0	Regenerator at 1800°F.
9/16	0032		Started feeding lignite to the gasifier.
"	0415		Started limestone to the system via F-206.
"	0800	25	Initiated the procedure to remove air from the gasifier.
"	1515		Finished grinding lignite.
"	1820		Balance gas for dPCV-2037, FR-2306, is plugged. Controlling dPCV-2037 with purge gas to S-10 sample station.
"	1930		Started grinding lignite.
"	2050		dPCV-2037 back on automatic, FR-2306 unplugged.
9/17	0740		Finished grinding lignite.
"	0912		Shut down J-201B and J-207A and B, they are no longer needed.
"	1055		Initiated CO_2 flow to the gasifier boot.
"	1300	54	Started grinding lignite again.
"	1600		All air out of the gasifier side flow.
"	1738		Lignite feed from F-204A stopped for approximately two minutes.
"	1747		Experienced a power dip. No problems developed.
"	1835		Attempting to determine the optimum lignite feed rate.
9/18	0410		Finished grinding lignite, shut down grinding system.
"	0700	72	Slowly lining out lignite feed to the gasifier.
"	1200		Started grinding lignite again.
"	1400		dPR-2026 adjusted in order to lower the amount of N_2 in the gasifier overhead gas.
"	1630		FR-2306, balance gas to dPCV-2037, plugged.
"	1655		FR-2306 back in service.
"	1930		UAD-206, purged dolomite line, plugged. NOTE: Overpressured F-213 and blew the plug back into the gasifier.
"	2255		Steam boiler shut down. NOTE: Immediately introduced recycle gas into the gasifier boot and side flows and stopped acceptor circulation. After getting steam back, all recycle gas routed to the boot flow and steam was placed in the side flow. The gasifier interface was deliberately blown away in order to prevent solids buildup. The char transfer was lost, however, the auxiliary char feed kept the regenerator bed hot. The lignite feed to the gasifier was replaced with char. Inert gas was used in the preheater ring to keep it clear.

Date	Time	Hours Counting	Description
9/18	2305		Steam placed back into the preheater and the bed lifted.
9/19	0040		Finished grinding lignite.
"	0115		All solids transfer back and began lining out the system.
"	0345		Started grinding char.
"	0600		Started feeding lignite to the system.
"	0800	97	Began lowering the auxiliary char feed rate and increasing the char transfer and slowly increasing steam to the boot.
"	0820		Slowly increasing the acceptor circulation.
"	0830		Finished grinding char and began grinding lignite.
"	1400		Finished grinding lignite and started grinding char.
"	1545		A restriction developed in the 180 degree section of the acceptor lift gas line.
"	1630		Stopped grinding char to permit maintenance to change the dust bags in the baghouse.
"	2000		Line to purged acceptor hopper plugged. NOTE: Cleared plug by blowing it into the gasifier.
"	2125		Char transfer lost. NOTE: The seal on LCV-2002 was lost, and, therefore, auxiliary char and acceptor circulation were stopped.
"	2210		Char transfer regained, auxiliary char was fed and the acceptor circulation was slowly increased.
9/20	0445		Maintenance finished with the baghouse, started grinding lignite.
"	1000	123	Continuing to increase lignite feed and lower the auxiliary char feed.
"	1315		Checked out the gas lines to the methanation unit.
"	1415		Gasifier density coming down after cutting the acceptor circulation rate and reducing the gasifier boot flow.
"	1810		Finished grinding lignite.
"	2015		Started grinding char.
"	2300		Continuing to adjust gas flows and solids feed rates.
"	2400		Finished grinding char.
9/21	0135		Started grinding lignite.
"	1330	150.5	Checked process gas lines to the methanation unit.

Date	Time	Hours Counting	Description
9/21	1340		Finished grinding lignite, shut the 100 area down.
"	1628		The automatic programmer on the char removal system is malfunctioning.
"	1806		Automatic programmer worked properly after going through the sequence several times on manual.
"	1900		Started grinding lignite for the preheater.
9/22	0700	168	Slowly increasing acceptor circulation in order to remove all recycle gas from the gasifier boot flow.
"	0830		Finished grinding lignite and started grinding char.
"	1030		Adjusted the gasifier boot flows in order to remove all recycle gas from the gasifier boot flow.
"	1145		Finished grinding char and shut down the 100 area.
"	1600	179	All gasifier recycle gas out of the gasifier boot flow. Started grinding lignite for the preheater.
"	1919		Controlling the gasifier bed level with auxiliary char.
"	2300		The gasifier density decreased from 39 LBS/CU FT to 34 LBS/CU FT. Increased the acceptor circulation slightly in order to increase the gasifier bed temperature.
9/23	1030		Stopped grinding lignite to permit maintenance to change out the baghouse bags.
"	1200	197	Calcined acceptor sample station plugged. Station cleared by rodding.
"	1745		Maintenance finished with the 100 area and began grinding lignite for the preheater.
"	2400		Process lined out all day, changes limited to slight adjustments in solids flow rates.
9/24	0115		Experiencing an unstable interface in the gasifier boot. LCV-2003 unable to control the level. Stopped fresh lignite feed, acceptor circulation, fresh limestone makeup. Char/acceptor interface lost.
"	0250	211.4	Increased the gasifier boot flow with gasifier recycle gas and deliberately blew away the interface in order to prevent the bed from setting up. Placed the ZnO towers on line and began decreasing the steam to the gasifier.
"	0330		Reestablished the interface in the gasifier and succeeded in starting acceptor circulation. NOTE: Acceptor transfer through LCV-2003 was established after blowing gas both ways through S-10 sample station.

Date	Time	Hours Counting	Description
9/24	0400		Started feeding char to the gasifier via F-204B.
"	0430		Established char transfer to the regenerator.
"	0545		Lost char transfer.
"	0610		Regain char transfer.
"	0815		Finished grinding lignite and started grinding char.
"	1010		Started feeding lignite to the gasifier.
"	1045	219.7	Started reducing the auxiliary char feed to the regenerator.
"	1135		Finished grinding char and resumed grinding lignite.
"	1140		Started removing recycle gas from the gasifier boot flow and replacing it with steam.
"	1450		Finished grinding lignite and shut down the 100 area.
"	1940		Started grinding lignite again.
"	2100		J-207A and B and J-201B compressors taken off line.
9/25	0320	236.3	All gasifier recycle gas removed from the gasifier boot flow.
"	1045		Switched from grinding lignite to grinding char.
"	1240		Finished grinding char and resumed grinding lignite.
"	1600	249	Setting up the solids feed rates for steady-state operation.
"	1740		F-207A, lignite feeder, stopped for several minutes, upset the system slightly.
"	1845		Stopped grinding lignite and started grinding char.
"	2020		Finished grinding char and resumed grinding lignite.
9/26	0908		Experiencing low pressure in the city water supply line and switched the quench tower supply water over to the boiler feedwater system.
"	0920	266.3	City water supply back to normal and switched the quench towers back to potable water.
"	1530		Switched from grinding lignite to grinding char.
"	1650		Finished grinding char and keeping the 100 area heated up.
"	1815		Started grinding lignite for the preheater.
9/27	0230		The gasifier boot becoming unstable, increased the gasifier boot flow slightly and the system lined out.
"	0400		S-10 sample station and FR-2306 balance gas purge plugged.

Date	Time	Hours Counting	Description
9/27	0820	289.3	The gasifier interface unstable. Increased boot flow without any effect. Stopped acceptor transfer through TCV-2030, lignite feed and fresh dolomite feed. Increased boot flow with gasifier recycle gas and blew the interface to prevent setting up of the bed. Transfer through LCV-2003 impossible. Attempted to blow acceptor lift gas up through CD-204 without success. Placed ZnO towers on line.
"	1132		Removed CO_2 from the gasifier boot flow.
"	1217	294.3	Unable to recover the gasifier interface or acceptor transfer through LCV-2003, began cooling the system for shutdown. ZnO towers taken off line.
"	1230		Stopped grinding lignite and shut down the 100 area.
"	0500		System depressured.

4 RESULTS AND DISCUSSION

4.1 BACKGROUND

Tymochtee dolomite from Ohio was used as raw acceptor feedstock in all runs prior to Run 28 in which integrated plant operation was demonstrated. Since considerable operating data with the dolomite acceptor had been accumulated particularly for Runs 21, 26, and 27, a decision was made to switch to a new acceptor feedstock. Minnekahta limestone which is quarried in Rapid City, South Dakota, was selected. The material was readily available and had proven to be a suitable acceptor in bench-scale studies. As in all runs since Run 15, dead-burned dolomite was used for the initial regenerator inventory. When operating temperatures were reached in the regenerator, the dead-burned inventory was gradually replaced with fresh limestone. This technique of eliminating the generation of excessive quantities of acceptor fines and regenerator deposits worked equally well for the limestone acceptor as it had in previous runs for the dolomite.

4.2 ACCOMPLISHMENTS

4.2.1 Major Operational Achievements

The pilot plant operations for Runs 28A and 28B are summarized below:

Run	Process Conditions	Lignite Feed	Acceptor Circulation	Fresh Acceptor Makeup	Without Gasifier Air	100% Steam to Boot
28A	63.5	56	78	41	5	0
28B	289	255	304	265	232	85

The statistics for Run 28B are the most impressive for the pilot plant operation to date. The plant operated in an integrated manner for nearly ten days with the acceptor supplying all the gasifier heat requirements. Additionally, two balance periods of 33 and 40 hours respectively were obtained in which the pilot plant operation was truly at steady-state conditions. For these balance periods, the only gasifier inputs were steam, calcined acceptor, and raw lignite feedstock. Recycle gas was nct used in the gasifier for fluidization.

4.2.2 Plant Data

The pertinent data for both runs are presented in Tables 28-1 through 28-20. Operating conditions are shown in Tables 28-1 through 28-4. Feedstock compositions are contained in Tables 28-5 and 28-6.

Analyses of the effluent and circulated process streams which contain solids are presented in Tables 28-7 through 28-18. Preheat conditions of the feed streams are given in Table 28-19.

Plant pressure balance data are presented in Table 28-20 for Run 28B. The calculated pressure balances are included at the bottom of the table. Locations and elevations for the pressure points are shown in Figure 28-1.

Before the pressure balances were calculated, all the raw data shown in Table 28-20 were corrected to account for the density difference between the pressure tap purge gas and the process gases. These corrections have been discussed in detail in the Run 17 Report. Also, since there are always small errors associated with instrument calibration and the physical reading of the instruments, the pressure summation had to be forced to equal zero around the two loops (loop 1, 5, 9, 1 and loop 1, 14, 9, 1; see Figure 28-1). Forcing was done by equally distributing the summation errors between the various measured differential pressures in the loops. Except for two cases, the summation errors were always less than 6 percent of the measured values.

4.2.3 Activity

The acceptor activity which is a measure of the acceptor's ability to react with CO_2 is defined as the moles of active calcium oxide per mole of calcium in the stone. In Figure 28-2, the activity of the circulating acceptor inventory is plotted as a function of time for both Runs 28A and 28B. As shown, the limestone activities are considerably lower than the activities obtained in earlier runs in which dolomite was used as feedstock. However, if the ability to react with CO_2 for the limestone and dolomite acceptors is compared based upon pounds of CO_2 reacted per pound of stone, the two acceptors have nearly equivalent capacities. This is because the limestone contains approximately 1.9 times as much calcium as does dolomite. Thus, on a pound basis, a limestone acceptor with an activity of 0.14 would be equivalent to a dolomite with an activity of 0.27.

As shown in Figure 28-2, Run 28A was not of sufficient length to allow complete change out of the dead-burned dolomite inventory. However, the activity behavior for the run generally followed the trend for Run 28B.

For Run 28B there are two distinct periods for which the acceptor activity had apparently lined out. Since the parameters which affect activity are not yet well defined, only a qualitative explanation can be made at this time for the differences in the two periods. One possible cause for the greater activity achieved during the first period is the acceptor residence time in the gasifier. Laboratory experiments have demonstrated that long gasifier residence times tend

to reduce the rate of acceptor deactivation[1]. The gasifier residence time for the first period was estimated to be approximately 10 percent longer than that for the second period.

4.2.4 Intermediate Fines

During both runs the char removal system adequately controlled the accumulation of intermediate fines. Figure 28-2 shows the concentrations of this "junk" material in the regenerator bed and in the gasifier char bed during Run 28B. For a discussion of the procedure for determining the intermediate fines concentrations, the reader is referred to the run report which covers Runs 21, 22, and 23.

As shown in Figure 28-3, the gasifier char bed intermediate fines concentration was relatively low during both balance periods. For the first balance period, the fines represented approximately 9 weight percent of the char bed, while for the second period, the concentration was 10 weight percent. These levels were achieved by purging an average of 150 LBS/HR and 215 LBS/HR of char bed material from the gasifier during the first and second balance periods respectively. These purge rates represent respectively 75 LBS/HR and 115 LBS/HR of char material with the remainder being acceptor and intermediate fines.

4.3 PROBLEMS

4.3.1 Gasifier Quench System Operation

The operation of the gasifier quench system has been a major cause of gasifier pressure upsets in the past. Following Run 22A, extensive revisions were made to the system to improve the operation. These revisions were made to the system to improve the operation. These revisions are discussed in the report for Runs 22 and 23. The revisions reduced the occurrences of the pressure upsets but did not eliminate them. Calcium rich scales continued to form in the quench tower which would periodically slough off the walls and block the tower drain lines.

Attempts at eliminating the tower scale formations were initially concentrated on providing the gas-solids-liquid contacting. Prior to Run 24, a vertically positioned venturi was installed ahead of the quench tower inlet. This was done based upon the very successful regenerator quench system design. However, the run ended when scale which had formed in the piping downstream of the venturi broke away from the walls and plugged the quench tower gas inlet. A new approach to solving the scale formation problem was then taken. Betz Laboratories

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[1] Lancet, M. S., RM-13943, "Effect of Regenerator and Gasifier Residence Times on Various CO_2 Acceptors," October 8, 1975.

of Trevose, Pennsylvania, was hired to study the problem and to provide water treatment chemicals to eliminate the scale formation. Preliminary results are encouraging and have demonstrated that the scale formation can be easily minimized. A comprehensive report covering the quench system operation will be issued when work in this area is completed.

4.3.2 Deposits

Agglomerated limestone deposits were found in the gasifier following the shutdowns for both Runs 28A and 28B. The 28A shutdown revealed a massive deposit which totally filled the gasifier transition section. The deposit was hard and had areas that appeared to have been liquid at one time. A smaller deposit which covered the boot gas distributor caps and which extended into the boot nozzle leading to the recarbonated acceptor standleg was also found. Both deposits formed after the boot upset which caused the plant to be shut down. Prior to upset, the gasifier temperature and differential pressure instrumentation did not reveal the presence of any deposits. Additionally, since acceptor circulation was smooth and trouble-free throughout the run, a massive deposit in the transition section could not have formed until after the upset.

The formation of the gasifier deposits is consistent with what is known about the chemistry of the process. Shortly after the boot upset, the temperature in the transition section dropped from 1480^{o} to 1200^{o}F. The steam partial pressure at the time was 9.6 atmospheres. At 1200^{o}F, a steam partial pressure of only 8.8 to 9.0 atmospheres is sufficient to cause the formation of calcium hydroxide. The hydroxide in the presence of calcium carbonate formed liquid melts which agglomerated and glued together the acceptor in the transition section. In the future, efforts will be made to insure that conditions favorable for melt formation (i.e., high steam partial pressure and temperatures between 1180^{o} to 1230^{o}F) do not exist in the gasifier at any time. The most effective means of avoiding these conditions during an upset will be to reduce the steam partial pressure to 5 to 6 atmospheres by supplying recycle gas to the gasifier boot.

The boot deposit which was discovered during the Run 28B shutdown filled the entire gasifier boot cross section and extended to within one foot of the transition section. The deposit was wet and caked in appearance. Apparently, during shutdowns steam condensed on the collected acceptor causing the acceptor to agglomerate and slake. As with Run 28A, the 28B deposit had to have formed during or after the boot upset. Acceptor circulation which was normal until the upset could not have been maintained if the deposit had been present.

Inspection of the regenerator after both runs did not reveal any unusual deposits. Typical thin wall scales (less than one-half inch thick) and the usual lip deposit of fused char ash were observed.

The lip deposit always forms just below the char inlet line on the reactor walls. It normally extends 3 to 5 inches from the reactor wall and from 10 to 20 inches along the wall circumference. The deposit is not considered to be a problem since it appears to grow to an equilibrium size and does not interfere with the regenerator operation.

After Run 28B, a pipe scale of agglomerated acceptor fines (80 WT % CaO) was discovered in the calcined acceptor return line, CD-206. Similar scale was found during Run 14 when carbon dioxide bearing gases were used to purge the line. Laboratory tests have demonstrated that recarbonation of the acceptor in the standleg could cause scale formation. However, since Run 16 the use of nitrogen as the purge gas to the line had apparently eliminated the scale problem. Possible causes for the Run 28B scale include: (1) the use of limestone acceptor; (2) the production of sticky fines due to oxygen breakthrough in the regenerator (a condition which occurred at least three times during the run); and (3) operation of the system at a low differential pressure (1 to 1.5 PSI) between the regenerator and the gasifier. Operation at low differential pressure might have allowed some carbon dioxide in the regenerator flue gases to enter the standleg with the calcined acceptor and thus cause some recarbonation. Unfortunately, at this time the cause cannot be determined.

4.3.3 Heater Deterioration

The acceptor lift gas heater, B-205, was inspected after both Runs 28A and 28B. Due to general thinning and the discovery of a pinhole, a 10-foot section of one tube pass was replaced after Run 28A. After Run 28B the heater coil was replaced because of the coil's deteriorated condition.

The coil which was replaced had been in service since Run 25 and had logged a total of 919 hours at temperatures about 1000°F. This coil which was the original or alpha coil had been rebuilt prior to Run 25. The hot outlet ends which were originally Incoloy 800 were replaced with alonized RA-330 material as were other thinned sections in the heater.

Sulfur attack in the tubes appear to be the primary cause of failure. During Run 28B, iron-nickel sulfide material flowed out of the heater and solidified at the water cooled pipe flange upstream of the engager pot. For a period of time, this deposited material restricted lift gas flow. However, most of the material apparently remelted and was carried harmlessly into the regenerator with the circulating acceptor.

Since the lift gas heater is only expedient for pilot plant operation and since relatively long periods of operation can be obtained from a heater coil, the operating philosophy has been to live with the problem and to minimize it by using sulfur resistant alloys

such as alonized materials. The new coil which was installed after Run 28B was made of Inconel 702. This material, because it contains 3-1/4 percent aluminum, may potentially be more resistant to sulfur attack than alonized materials or Incoloy 800.

5 FUTURE PLANS

To increase the reliability of the interface control at high circulation rates, the recarbonated acceptor standleg diameter will be increased from 4 inches to 6 inches. The balance gas ahead of the level control valve, LCV-2003, in this line and the sample station purge will be changed from 200 PSIG gasifier recycle gas to 350 PSIG inert gas. The use of a higher pressure purge gas should help eliminate tap plugging due to flow reversals caused by system pressure swings.

Plans for the next run also include the use of limestone acceptor and Velva lignite feedstocks. Additionally, attempts will be made to operate the methanation system for the first time.

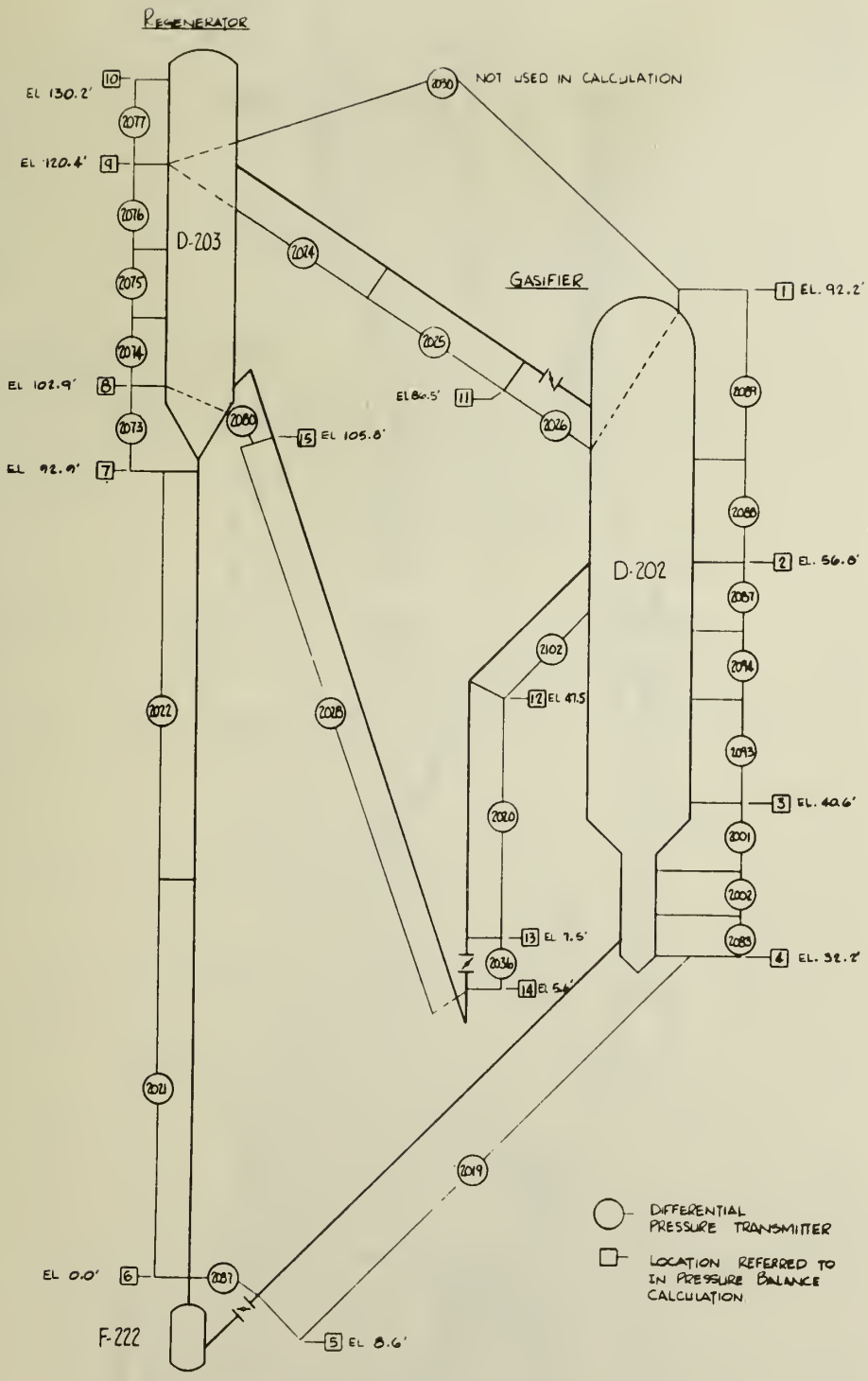

Figure 28-1. DIFFERENTIAL PRESSURE TRANSMITTER LOCATION, PRESSURE BALANCE CALCULATION

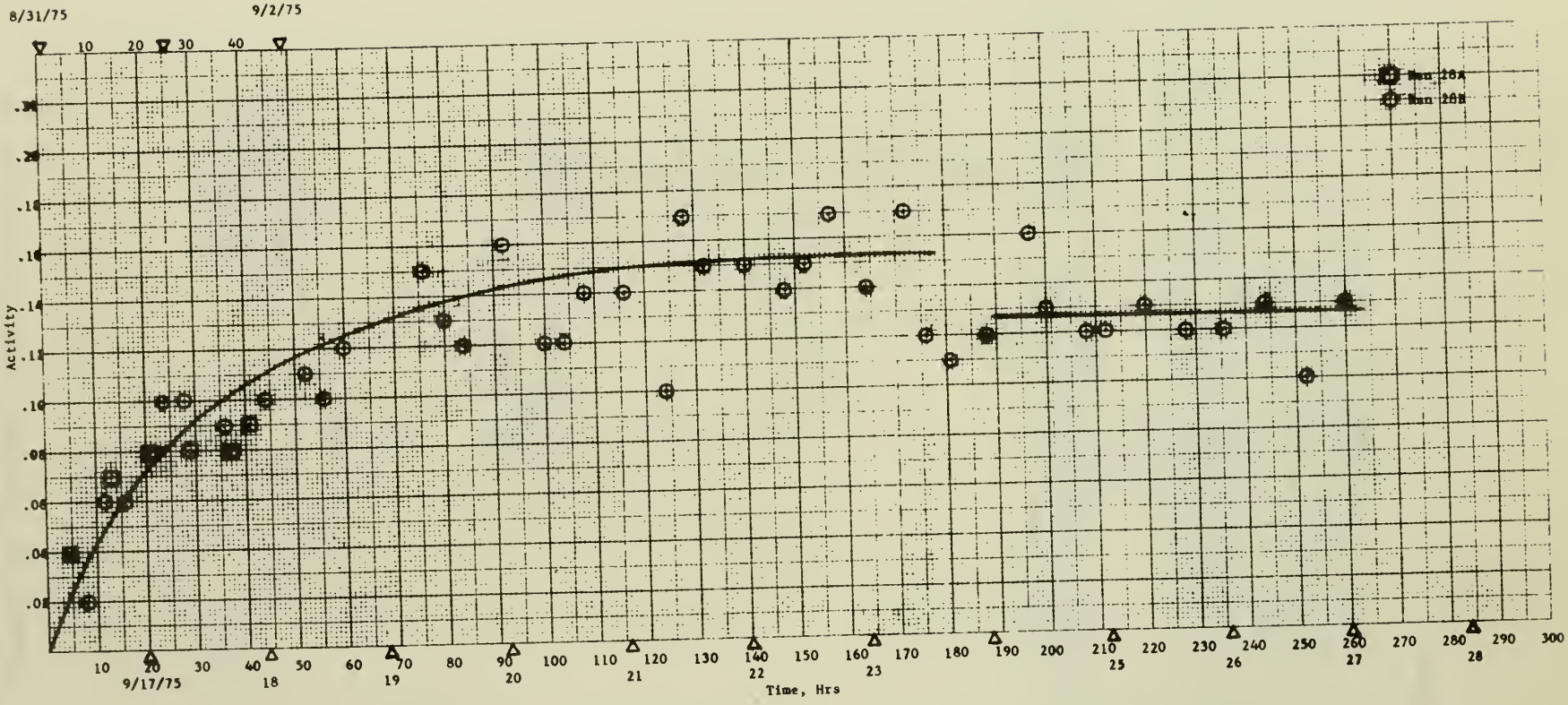

Figure 28-2. ACCEPTOR ACITVITY BEHAVIOR DURING RUNS 28A AND 28B

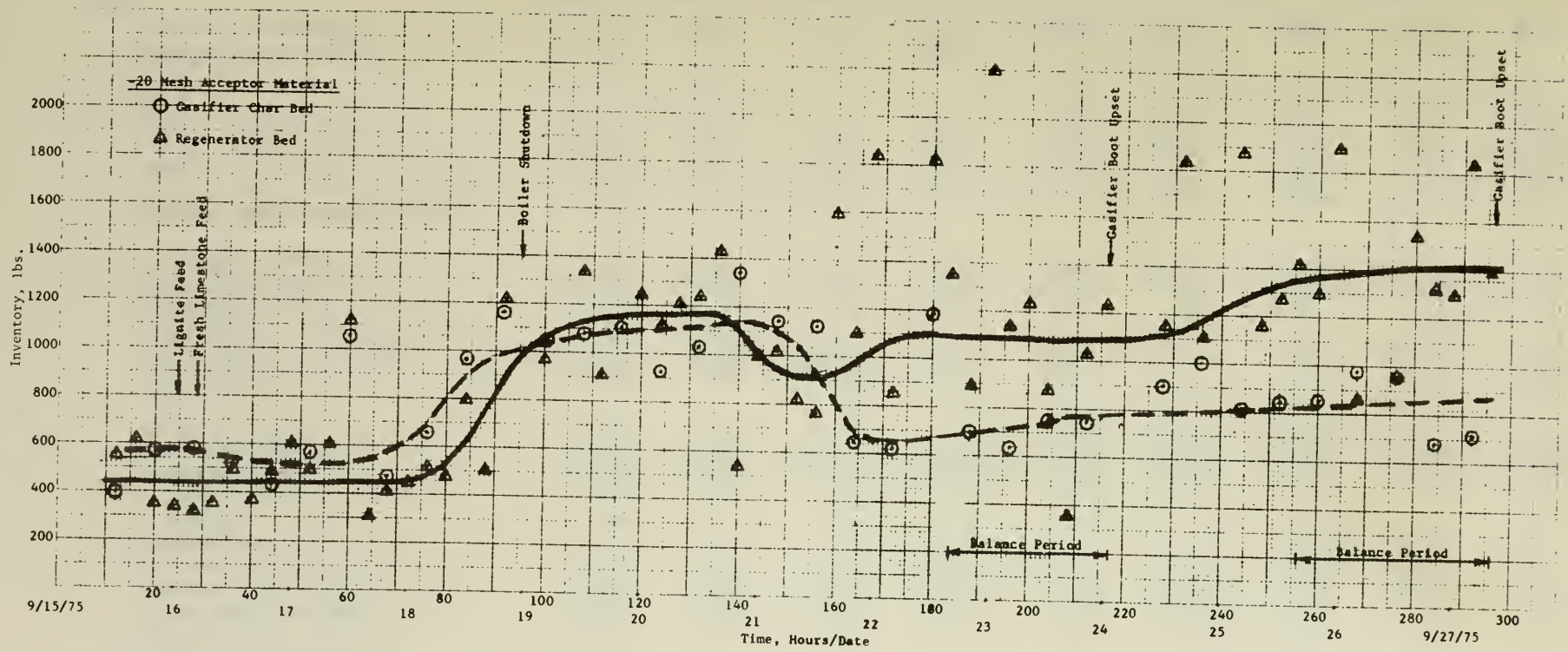

Figure 28-3. INTERMEDIATE FINES INVENTORY, RUN 28B

Date	8/29/75	←	8/30/75	→	←	8/31/75	→		9/1/75
Time	2300	0700	1500	2300	0700	1500	2300	0700	1500
Jacket Steam Make, lb/hr	0	0	0	0	0	0	0	0	0
Solids									
Feedstock	Husky Char			←		Velva Lignite		→	
Feed Rate, lb/hr[1]	1,770	1,240	1,590	2,300	2,480	2,660	2,580	2,120	2,300
Char Dump, lb/hr	631	238	175	180	155	181	137	186	137
Dump Acceptor, lb/hr	677	222	390	722	412	345	129	400	-
Gasifier Overhead Solids, lb/hr	105	194	209	209	282	219	178	147	-
Gas Flows[2]									
Boot (Recycle), SCFH	18,000	15,000	15,300	16,500	15,800	11,400	8,720	6,360	8,440
Boot (Steam), SCFH	19,400	18,800	19,500	21,000	23,300	28,100	34,300	34,300	34,300
Steam to Side, SCFH	31,500	31,400	31,000	31,300	32,000	28,200	21,100	21,100	21,100
Air to Side, SCFH	19,500	19,200	18,900	18,800	17,300	13,000	8,280	4,100	0
Purges									
Recycle, SCFH	3,390	3,390	3,390	3,390	3,250	4,110	4,870	3,710	4,480
Inert, SCFH	221	221	221	221	285	221	221	221	253
Total Flow In, SCFH	92,011	88,011	88,311	91,211	91,935	85,031	77,491	69,791	68,573
Vent Rate, SCFH	22,500	55,400	61,500	76,100	71,400	70,400	65,300	52,300	57,300
Bed Conditions									
Boot Velocity, ft/sec	1.80	1.88	1.86	1.97	2.07	2.00	2.01	2.07	2.11
Char Bed Velocity Inlet, ft/sec	0.87	0.90	0.90	0.93	0.94	0.84	0.72	0.69	0.65
Boot Density, lb/ft^3[3]	110	108	104	104	102	9	95	92	87
Char Bed Density, lb/ft^3[3]	44	42	34	34	34	36	35	32	36
Boot Temperature, °F	1331	1549	1484	1469	1515	1516	1504	1496	1497
Char Bed Temperature, °F	1342	1479	1480	1470	1500	1501	1499	1492	1494
Overhead Gas Composition, Mol %									
CO	8.1	15.9	16.5	17.0	17.5	17.0	16.8	15.2	10.5
CO_2	23.8	18.4	21.3	15.0	17.1	14.6	8.8	11.3	6.6
N_2	34.9	27.8	22.5	23.0	18.5	15.6	14.3	7.8	3.5
H_2	27.8	34.4	34.2	36.3	39.3	43.7	49.4	54.2	69.4
CH_4	5.4	3.6	5.5	7.4	7.6	9.1	10.7	11.5	10.0
C_2H_6	-	-	-	-	-	-	-	-	-
PPM H_2S	-	-	-	9000	-	-	-	-	-
H_2O Mol Fraction[4]	37.4	28.0	30.2	23.6	28.1	27.7	20.8	28.8	30.5

(1) Determined by feeder RPM - RPM*354
(2) Determined by orifice flow meter measurements
(3) Determined by differential pressure measurements
(4) Calculation based on water-gas shift equilibrium

Table 28-1. GASIFIER DATA, RUN 28A

Date	8/29/75	← 8/30/75 →		← 8/31/75 →				9/1/75	
Time	2300	0700	1500	2300	0700	1500	2300	0700	1500
Jacket Steam Make, lb/hr	180	300	250	230	230	250	380	410	220
Solids									
Acceptor Feedstock	Dead-Burned Dolomite			←		6 X 9 Minnekahta		→	
Acceptor Makeup, lb/hr(1)	360	360	360	560	560	560	560	560	560
Acceptor Circulation, lb/hr(2)	3,700	9,830	12,200	16,500	14,400	15,500	14,000	13,400	13,900
Ash & Attrited Acceptor, lb/hr(3)	←	Weigh Scales Out Of Service				→	150	121	103
Auxiliary Char Feed, lb/hr(1)	55	55	114	121	121	118	118	118	118
Gas Flows(4)									
Acceptor Lift, SCFH	61,000	59,500	59,600	59,500	58,900	54,100	54,300	54,000	53,700
Char Lift, SCFH	9,990	10,100	10,100	10,100	10,100	10,100	10,000	10,100	10,000
Air Line									
Recycle, SCFH	61,900	35,300	30,200	15,100	13,000	0	0	0	0
Air, SCFH	50,600	50,600	54,700	61,500	74,600	79,500	80,900	80,100	83,900
Purges									
Recycle, SCFH	2,440	2,440	2,440	2,440	2,950	28,60	2,460	3,110	3,110
Nitrogen, SCFH	1,740	1,400	1,570	1,780	1,580	1,780	1,490	1,490	1,400
Total Flow In, SCFH	187,670	159,340	158,610	150,420	161,130	148,340	149,150	148,800	152,110
Vent Rate, SCFH	62,000	59,000	64,300	72,000	92,000	100,800	105,200	101,700	107,900
Bed Conditions									
Gas Velocity Inlet, ft/sec	2.87	2.87	2.86	2.74	2.91	2.66	2.72	2.70	2.75
Bed Density, lb/ft^3(5)	82-127	79-120	84-120	84-112	82-115	73-106	76-105	72-102	64-94
Average Bed Temperature, °F	1470	1820	1825	1848	1830	1828	1849	1853	1842
Overhead Gas Analyses, Mol %									
CO		1.07	3.54	2.60	3.25	3.1	4.4	3.1	2.6
CO_2	8.75	19.17	17.15	17.95	22.90	22.1	22.9	25.0	25.9
N_2	91.40	70.76	70.31	70.45	73.85	74.9	72.8	71.9	71.5

(1) Determined by feeder RPM; dead-burned dolomite, 360 * RPM; limestone, 281 * RPM; auxiliary fuel, 368 * RPM
(2) Determined by lift line pressure drop measurements
(3) Determined by weigh scale measurements
(4) Determined by orifice flow meter measurements
(5) Density indicated by pressure tap readings

Table 28-2. REGENERATOR DATA, RUN 28A

Date	9/15/75			9/16/75			9/17/75			9/18/75			
Time	0700	1500	2300	0700	1500	2300	0700	1500	2300	0700	1500	1900	2300
Jacket Steam Make, lb/hr	0	0	0	0	0	0	0	0	0	0	0	0	Plant Upset
Solids													
Feedstock	Husky Char			Velva Lignite									
Feed Rate, lb/hr(1)	1,540	1,160	1,430	2,030	2,470	2,470	2,510	2,430	2,200	2,080	2,160	2,340	
Char Dump, lb/hr	260	184	232	199	115	118	94	115	107	127	137	137	
Dump Acceptor, lb/hr	332	332	471	630	338	263	377	193	283	256	341	341	
Gasifier Overhead Solids, lb/hr	-	-	-	221	229	157	196	244	133	154	207	250	
Gas Flows(2)													
Boot (Recycle), SCFH	21,000	19,700	19,700	20,400	17,700	14,900	12,500	12,500	12,000	12,900	12,600	8,900	
Boot (Steam), SCFH	19,000	19,100	18,900	18,600	24,000	29,500	34,800	34,300	34,700	34,200	34,200	34,200	
CO_2 to Boot, SCFH	0	0	0	0	0	0	0	1,010	1,020	1,030	960	960	
Steam to Side, SCFH	30,100	30,700	31,300	31,200	31,000	27,500	20,100	20,800	21,100	21,600	21,400	22,800	
Air to Side, SCFH	19,500	19,600	19,700	19,700	17,000	12,200	7,020	2,650	0	0	0	0	
Purges													
Recycle, SCFH	2,880	2,970	2,960	3,200	3,330	3,330	3,300	3,670	3,730	3,970	3,970	3,970	
Inert, SCFH	329	329	329	296	329	329	329	329	296	296	320	320	
Total Flow In, SCFH	92,809	92,399	92,889	93,396	93,359	87,759	78,049	75,259	72,846	73,996	73,450	71,150	
Vent Rate, SCFH	42,000	50,800	56,200	69,500	72,100	62,200	56,400	49,100	39,400	41,000	39,900	38,600	
Bed Conditions													
Boot Velocity, ft/sec	2.07	2.04	2.11	2.15	2.27	2.22	2.17	2.30	2.24	2.28	2.24	2.14	
Char Bed Velocity, Inlet, ft/sec	0.90	0.92	0.97	0.98	0.97	0.89	0.73	0.71	0.68	0.69	0.68	0.67	
Boot Density, lb/ft^3(3)	110	108	104	104	101	96	95	93	93	95	90	93	
Char Bed Density, lb/ft^3(3)	40	37	40	32	31	31	32	35	36	37	37	37	
Boot Temperature, °F	1369	1432	1478	1505	1519	1523	1504	1510	1493	1493	1486	1476	
Char Bed Temperature, °F	1330	1406	1472	1493	1500	1495	1494	1495	1487	1489	1485	1468	
Overhead Gas Compositions, Mol %													
CO	9.1	13.5	17.2	19.1	19.0	17.1	16.8	16.2	14.6	14.2	13.7	13.3	
CO_2	20.0	17.9	16.3	13.1	10.8	13.2	8.8	9.4	9.2	8.8	9.3	9.3	
N_2	39.9	33.9	32.4	26.1	23.0	17.4	16.9	7.7	4.5	4.4	3.6	3.4	
H_2	26.3	29.6	30.5	35.7	39.6	43.1	49.1	53.8	57.5	58.5	59.4	58.6	
CH_4	4.7	3.6	3.6	6.0	7.6	9.1	8.4	12.8	14.2	14.1	14.0	15.4	
H_2O Mol Fraction	-	-	-	22.4	19.0	23.2	14.8	18.8	26.7	27.8	28.8	-	

(1) Determined by feeder rpm (386*RPM)
(2) Determined by orifice flow meter measurements
(3) Determined by differential pressure measurements

Table 28-3. GASIFIER DATA, RUN 28B (Sheet 1 of 3)

Date	← 9/19/75 →			← 9/20/75 →			← 9/21/75 →			← 9/22/75 →		
Time	0700	1500	2300	0700	1500	2300	0700	1500	2300	0700	1500	2300
Jacket Steam Make, lb/hr	0	Plant Upset	0	0	0	0	0	0	0	0	0	0 Balance Period
Solids												
Feedstock	← Velva Lignite →											
Feed Rate, lb/hr(1)	1,160		1,290	1,650	1,970	1,990	1,970	2,120	2,320	2,320	2,350	2,370
Char Dump, lb/hr	245		153	138	167	263	283	226	236	221	221	194
Dump Acceptor, lb/hr	210		353	295	220	284	209	279	221	214	258	342
Gasifier Overhead Solids, lb/hr	93		129	156	187	144	232	186	131	141	180	152
Gas Flows(2)												
Boot (Recycle), SCFH	20,000		9,220	8,640	9,090	8,980	8,010	7,440	7,870	8,260	3,390	0
Boot (Steam), SCFH	20,600		34,200	33,900	35,000	34,900	34,800	33,300	34,100	33,800	37,200	30,800
CO_2 to Boot, SCFH	960		960	950	950	920	910	940	930	930	900	920
Steam to Side, SCFH	21,900		21,700	21,800	22,200	22,200	22,200	21,300	19,300	19,200	17,800	17,400
Air to Side, SCFH	0		0	0	0	0	0	0	0	0	0	0
Purges												
Recycle, SCFH	4,620		4,500	4,840	4,900	4,660	4,660	4,610	4,500	4,500	4,120	4,310
Inert, SCFH	304		312	296	329	320	320	296	296	296	394	312
Total Flow In, SCFH	68,384		70,892	70,426	72,469	71,980	70,900	67,886	66,996	66,986	63,804	59,742
Vent Rate, SCFH	25,100		35,000	37,700	41,600	42,700	41,200	45,000	47,800	48,000	46,000	49,800
Bed Conditions												
Boot Velocity, ft/sec	2.23		2.04	2.13	2.04	2.03	1.96	1.93	1.95	1.96	1.89	1.89
Char Bed Velocity, ft/sec	0.68		0.64	0.66	0.65	0.65	0.63	0.62	0.60	0.60	0.57	0.57
Boot Density, lb/ft^3(3)	86		83	78	75	77	77	75	75	74	72	74
Char Bed Density, lb/ft^3(3)	38		35	33	37	38	36	35	36	36	37	36
Boot Temperature, °F	1511		1451	1509	1493	1495	1486	1507	1504	1495	1500	1497
Char Bed Temperature, °F	1481		1457	1503	1490	1487	1481	1495	1496	1491	1505	1497
Overhead Gas Compositions, Mol %												
CO	12.5		11.0	13.4	14.5	13.2	12.7	13.8	13.9	13.6	14.8	14.0
CO_2	6.6		11.2	9.3	4.6	7.3	9.8	10.1	9.6	5.9	9.4	10.1
N_2	8.0		7.0	4.8	4.5	3.8	3.9	4.8	3.8	5.6	4.4	4.0
H_2	58.9		58.8	60.1	63.3	61.7	60.0	58.5	59.3	61.1	58.5	58.8
CH_4	14.0		12.0	12.4	13.1	14.0	13.6	12.8	13.4	13.8	12.9	13.1
H_2O Mol Fraction												

(1) Determined by feeder rpm (386*RPM)
(2) Determined by orifice flow meter measurements
(3) Determined by differential pressure measurements

Table 28-3. GASIFIER DATA, RUN 28B (Sheet 2 of 3)

Date	← 9/23/75 →			← 9/24/75 →			← 9/25/75 →			← 9/26/75 →			9/27/75
Time	0700	1500	2300	1100	1500	2300	0700	1500	2300	0700	1500	2300	0700
Jecket Steam Make, lb/hr	0	0	0	0	0	0	0	0	0	0	0	0	0
	← Belance Period →								← Belence Period →				
Solids													
Feedstock	← Velva Lignite →												
Feed Rate, lb/hr(1)	2,350	2,370	2,370	1,000	1,720	2,010	2,030	2,240	2,350	2,350	2,350	2,350	2,350
Char Dump, lb/hr	133	146	158	198	203	324	222	242	251	272	567		
Dump Acceptor, lb/hr	248	293	293	130	128	391	544	195	300	198	335	296	296
Gasifier Overhead Solide, lb/hr	140	234	214	102	210	195	175	190	157	143	194	221	179
Gas Flows(2)													
Boot (Recycle), SCFH	0	0	0	18,700	15,900	9,560	0	0	0	0	0	0	0
Boot (Steam), SCFH	37,000	36,900	37,200	22,800	28,000	35,300	40,900	40,300	40,500	40,500	41,300	42,100	42,000
CO_2 to Boot, SCFH	940	900	940	930	930	910	920	900	880	900	900	900	890
Steam to Side, SCFH	18,300	16,700	17,900	17,800	16,800	14,200	15,100	15,000	17,500	16,500	16,100	16,100	17,500
Air to Side, SCFH	0	0	0	0	0	0	0	0	0	0	0	0	0
Purges													
Recycle, SCFH	4,310	4,340	4,180	4,180	4,180	4,590	3,940	3,110	3,350	3,240	3,630	3,260	2,990
Inert, SCFH	312	345	345	345	345	329	360	360	260	230	230	263	263
Totel Flow In, SCFH	60,862	59,185	60,565	64,755	66,155	64,889	61,220	59,670	62,490	61,370	62,160	62,623	63,643
Vent Rate, SCFH	49,200	51,200	41,700	31,400	34,500	41,700	45,200	48,700	50,800	50,300	52,600	51,000	52,000
Bed Conditions													
Boot Velocity, ft/sec	1.91	1.92	1.92	2.20	2.30	2.14	1.94	1.92	1.98	1.95	1.98	2.01	2.01
Char Bed Velocity, Inlet, ft/sec	0.58	0.57	0.58	0.63	0.64	0.58	0.55	0.55	0.59	0.57	0.57	0.58	0.59
Boot Density, lb/ft^3(3)	74	72	72	72	72	75	75	75	74	75	75	75	74
Cher Bed Density, lb/ft^3(3)	34	34	33	36	36	37	33	32	34	34	33	33	32
Boot Tempereture, °F	1503	1500	1499	1524	1521	1512	1485	1492	1498	1490	1492	1486	1487
Char Bed Tempereture, °F	1493	1497	1490	1484	1490	1494	1483	1493	1497	1490	1487	1486	1488
Overheed Gas Compositions, Mol %													
CO	14.4	15.1	14.3	11.4	12.7	13.7	13.4	14.7	15.1	14.8	14.0	13.8	14.0
CO_2	9.2	8.7	10.4	7.8	7.0	8.5	10.3	9.8	8.3	9.4	8.8	9.2	8.4
N_2	3.8	4.2	3.9	15.4	4.3	5.6	4.5	4.2	5.2	4.7	4.8	4.2	4.3
H_2	59.4	58.9	58.2	54.2	62.0	60.2	59.7	58.5	59.0	58.6	59.6	59.7	60.2
CH_4	13.2	13.2	13.2	11.2	14.0	13.0	12.1	12.9	12.4	12.4	12.8	13.0	13.1
H_2O Mol Frection	-	-	22.7	-	-	-	28.0	31.8	29.6	-	27.2	31.2	-

(1) Determined by feeder rpm (386*RPM)
(2) Determined by orifice flow meter meesurements
(3) Determined by differential pressure meesuremente

Table 28-3. GASIFIER DATA, RUN 28B (Sheet 3 of 3)

Data	9/15/75			9/16/75			9/17/75			9/18/75			
Time	0700	1500	2300	0700	1500	2300	0700	1500	2300	0700	1500	1900	2300
Jacket Steam Make, lb/hr	320	230	230	250	270	250	240	220	220	310	320	310	Plent Upset
Solids													
Acceptor Feedstock	Dead-Burned Dolomite			6 X 9 Minnekahta Limestone									
Acceptor Makeup, lb/hr[1]	360	360	720	560	560	560	560	560	560	560	560	560	
Acceptor Circulation, lb/hr[2]	1,590	4,130	10,100	12,200	13,900	12,600	12,600	11,400	11,300	10,700	9,800	9,200	
Ash & Attrited Acceptor, lb/hr[3]	Inet. Out of Ser.		109	79	108	83	98	90	79	83	100	253	
Auxiliary Fuel Char, lb/hr[1]	0	55	55	55	55	55	55	55	55	55	55	55	
Gas Flows[4]													
Acceptor Lift, SCFH	59,900	60,300	60,100	59,700	54,300	54,700	53,900	54,200	54,200	54,200	54,300	54,300	
Cher Lift, SCFH	9,660	9,850	9,870	9,900	9,810	9,890	9,900	9,900	9,900	9,900	9,900	10,800	
Air Line													
Recycle, SCFH	41,600	32,700	23,400	21,200	0	0	0	0	0	0	0	0	
Air, SCFH	68,100	41,400	49,500	64,600	68,600	70,900	74,300	77,400	77,600	77,300	75,600	76,300	
Purges													
Recycle, SCFH	2,040	2,060	2,045	2,080	2,080	2,010	2,010	1,980	1,900	2,570	1,890	1,890	
Nitrogen, SCFH	2,500	2,300	2,380	2,210	2,210	2,210	2,210	1,780	1,450	1,400	1,320	1,320	
Total Flow In, SCFH	183,800	148,610	147,295	159,690	137,000	139,710	142,320	145,260	145,050	145,370	143,010	144,610	
Vent Rate, SCFH	76,800	50,700	55,900	73,700	84,500	90,800	96,300	98,300	98,900	99,600	99,750	99,600	
Bed Conditions													
Gas Velocity, Inlet, ft/sec	3.18	2.71	2.66	2.90	2.47	2.53	2.57	2.66	2.66	2.64	2.62	2.65	
Bed Density, lb/ft^3[5]	78-124	82-120	78-114	79-120	63-108	72-106	69-102	66-100	64-105	64-97	64-99	61-100	
Average Bed Temperature, °F	1729	1862	1838	1846	1836	1843	1836	1856	1856	1849	1854	1851	
Overhead Gas Analysis, Mol %													
CO	2.0	1.2	2.3	1.7	3.6	4.0	3.6	3.1	3.3	2.2	4.3	4.3	
CO_2	18.0	15.6	17.6	20.4	22.9	20.0	25.5	25.5	27.2	29.0	27.6	28.1	
N_2	80.1	83.3	80.1	77.9	73.5	75.0	70.9	71.5	69.6	68.9	68.1	67.7	

(1)
(2) Determined by feeder rpm: Dead-Burned Dolomite, 360*RPM; Limestone, 281*RPM; Auxiliary Fuel, 368*RPM
(3) Determined by lift line pressure drop measurements
(4) Determined by weigh scale measurements
(5) Determined by orifice flow meter measurements
Density indicated by pressure tap readings

Table 28-4. REGENERATOR DATA, RUN 28B (Sheet 1 of 3)

Date	← 9/23/75 →			← 9/24/75 →			← 9/25/75 →			← 9/26/75 →			9/27/75
Time	0700	1500	2300	1100	1500	2300	0700	1500	2300	0700	1500	2300	0700
Jacket Steam Make, lb/hr	360	365	300	345	320	345	320	290	210	200	390	390	405
Solids	← Balance Period →								← Balance Period →				
Acceptor Feedstock	← Minnekahta Limestone →												
Acceptor Makeup, lb/hr(1)	560	560	560	560	560	560	560	560	560	560	560	560	560
Acceptor Circulation, lb/hr(2)	12,100	12,600	11,400	7,660	8,540	9,800	9,690	11,200	10,300	11,200	11,746	12,000	11,100
Ash & Attrited Acceptor, lb/hr(3)	87	72	89	112	112	85	89	99	100	91	98	70	63
Auxiliary Fuel Char, lb/hr(1)	144	144	184	442	258	294	331	236	166	239	184	184	202
Gas Flows(4)													
Acceptor Lift, SCFH	50,400	50,300	49,900	49,500	50,400	50,100	50,900	50,600	50,700	50,900	50,740	50,700	50,600
Char Lift, SCFH	9,890	9,890	11,100	9,860	9,850	9,920	10,000	9,900	9,900	10,000	9,920	9,980	9,930
Air Line													
Recycle, SCFH	0	0	0		15,200	15,200	0	0	0	0	0	0	0
Air, SCFH	80,300	81,800	82,000	68,900	80,900	74,600	77,700	99,500	82,800	81,700	80,200	78,500	78,800
Purges													
Recycle, SCFH	2,170	2,080	2,130	2,130	2,130	2,130	2,130	2,420	2,130	1,840	1,790	1,790	2,410
Nitrogen, SCFH	1,020	1,040	1,040	1,040	850	1,040	1,060	1,270	1,100	1,060	1,060	1,060	1,060
Total Flow In, SCFH	143,780	145,110	146,070	146,630	159,330	137,790	141,790	163,690	146,630	145,500	143,710	141,940	142,800
Vent Rate, SCFH	109,000	110,000	103,000	88,600	102,000	94,200	96,800	99,500	104,000	104,000	102,530	101,000	101,000
Bed Conditions													
Gas Velocity, Inlet, ft/sec	2.63	2.64	2.66	2.67	2.94	2.51	2.58	2.59	2.69	2.66	2.64	2.58	2.60
Bed Density, lb/ft^3(5)	52-82	51-81	52-82	46-84	48-78	43-75	51-79	52-82	52-82	52-84	54-82	52-82	54-82
Average Bed Temperature, °F	1847	1836	1839	1832	1857	1836	1838	1830	1854	1840	1849	1830	1846
Overhead Gas Analysis, Mol %													
CO	2.8	3.0	2.9	2.3	2.6	2.3	2.6	2.7	2.3	3.1	2.8	3.4	2.4
CO_2	30.3	30.1	30.3	30.3	29.2	30.3	30.7	29.9	29.9	29.4	29.9	30.7	31.2
N_2	66.9	67.0	66.8	67.4	68.2	67.4	66.7	67.5	67.8	67.5	67.4	65.8	66.4

(1) Determined by feeder rpm: Dead-Burned Dolomite, 360*RPM; Limestone, 281*RPM; Auxiliary Fuel, 368*RPM
(2) Determined by lift line pressure drop measurements
(3) Determined by weigh scale measurements
(4) Determined by orifice flow meter measurements
(5) Density indicated by pressure tap readings

Table 28-4. REGENERATOR DATA, RUN 28B (Sheet 2 of 3)

Date	← 9/19/75 →			← 9/20/75 →			← 9/21/75 →			← 9/22/75 →		
Time	0700	1500	2300	0100	1500	2300	0200	1500	2300	0700	1500	2300
Jacket Steam Make, lb/hr	300	Plant Upset	360	365	365	365	365	370	370	350	360	365 Balance Period
Solids												
Acceptor Feedstock	← Minnekahte Limestone →											
Acceptor Makeup, lb/hr[1]	560		560	560	560	560	560	560	560	560	560	560
Acceptor Circulation, lb/hr[2]	4,900		9,380	8,870	9,700	9,710	8,830	12,400	10,600	10,600	12,300	12,100
Ash & Attrited Acceptor, lb/hr[3]	63		60	80	99	86	87	97	74	100	85	100
Auxiliary Fuel Char, lb/hr[1]	600		559	405	258	213	368	258	155	184	144	221
Gas Flows[4]												
Acceptor Lift, SCFH	53,800		50,600	50,700	50,600	50,500	50,600	50,600	50,500	50,500	50,200	50,400
Char Lift, SCFH	9,970		9,930	9,930	9,920	9,970	9,910	9,890	9,830	9,960	9,870	9,900
Air Line												
Recycle, SCFH	20,800		15,400	0	0	0	0	0	0	0	0	0
Air, SCFH	68,700		73,800	72,900	73,400	72,700	74,600	75,200	76,300	78,200	82,500	76,800
Purges												
Recycle, SCFH	2,820		2,230	2,420	2,420	2,320	2,320	2,220	2,220	2,220	2,850	2,170
Nitrogen, SCFH	1,270		1,530	1,150	980	980	1,020	1,020	1,190	1,190	1,270	1,020
Total Flow In, SCFH	157,360		153,490	137,100	137,320	136,470	138,450	138,930	140,040	142,070	146,690	140,290
Vent Rate, SCFH	88,400		98,100	91,000	97,400	92,700	96,000	94,900	97,000	99,900	105,000	100,000
Bed Conditions												
Gas Velocity, Inlet, ft/sec	2.90		2.74	2.52	2.52	2.48	2.52	2.52	2.54	2.59	2.65	2.55
Bed Density, lb/ft	61-94		61-97	54-82	52-82	51-82	52-82	49-78	49-82	51-82	51-81	52-82
Average Bed Temperature, °F	1876		1794	1867	1861	1836	1842	1831	1838	1844	1832	1837
Overhead Gas Anelysis, Mol %												
CO	3.8		2.4	3.9	3.1	2.9	3.3	1.9	3.1	3.1	2.7	3.1
CO_2	30.7		29.0	29.9	29.9	30.7	30.7	30.7	30.7	30.7	30.3	30.3
N_2	65.4		68.6	66.2	67.1	66.4	66.0	67.4	66.2	66.2	67.0	66.7

(1) Determined by feeder rpm: Dead-Burned Dolomite, 360*RPM; Limestone, 281*RPM; Auxiliary Fuel, 368*RPM
(2) Determined by lift line pressure drop measurements
(3) Determined by weigh scale measurements
(4) Determined by orifice flow meter measurements
(5) Density indicated by pressure tap readings

Table 28-4. REGENERATOR DATA, RUN 28B (Sheet 3 of 3)

Date 8/26/75 - 9/1/75

Screen Size Wt % Tyler Mesh	Acceptor: Dead-Burned Dolomite	Acceptor: Minnekahta Limestone	Screen Size, Wt % Tyler Mesh	Lignite: Husky Char	Lignite: Velva Lignite
+4			+6		
4 X 6			6 X 8		
6 X 8		34.3	8 X 10	0.7	0.8
8 X 9	0.9	29.3	10 X 14	5.7	8.6
9 X 10	9.7	21.1	14 X 20	12.0	12.6
10 X 12	26.6	9.0	20 X 28	17.4	17.1
12 X 14	37.3	4.6	28 X 35	18.4	17.8
14 X 16	20.2	1.0	35 X 48	20.9	12.7
16 X 20	3.8	0.3	48 X 65	12.6	15.3
20 X 24	0.4	0.1	65 X 100	6.9	7.2
24 X 28	0.9	0.1	100 X 200	4.0	5.4
-28	0.2	0.2	-200	1.4	2.5
Particle Density, lb/cu ft	205	160		42.3	
Ultimate Analysis, Wt %					
Moisture				3.40	1.50
C				69.28	64.22
H				2.60	4.74
S				1,39	0.43
Ash + SO_3				14.10	7.29
Elemental Analysis, Wt %					
SiO_2	1.88	3.80		28.98	20.78
SO_3	0.40	0.04		22.10	11.80
Na_2O	0.04	0.08		1.09	1.42
CaO	57.81	94.77		25.86	36.31
MgO	36.85	0.67		8.23	8.62
K_2O	0.02	0.04		0.27	0.26
P_2O_5	0.03	0.06		0.08	0.17
Al_2O_3	1.48	0.19		8.44	13.63
Fe_2O_3	1.50	0.32		5.33	1.14
TiO_2	0.12	0.05		0.52	0.57

Table 28-5. FEEDSTOCK COMPOSITES, RUN 28A

Date 9/12/75 - 9/27/75

Screen Size, Wt % Tyler Mesh	Limestone Minnekahta	Screen Size, Wt % Tyler Mesh	Lignite Husky Char	Lignite Velva Lignite
+4		+6		
4 X 6		6 X 8		
6 X 8	35.1	8 X 10	1.2	0.8
8 X 9	30.0	10 X 14	8.0	9.8
9 X 10	22.5	14 X 20	17.8	12.6
10 X 12	9.6	20 X 28	19.1	21.5
12 X 14	2.0	28 X 35	20.3	19.0
14 X 16	0.4	35 X 48	14.2	7.3
16 X 20	0.2	48 X 65	9.3	19.3
20 X 24	0.1	65 X 100	3.4	5.7
24 X 28	0.1	100 X 200	5.4	3.4
-28	Tr	-200	1.3	0.6
Particle Density, lb/cu ft			42.5	40.1
Ultimate Analysis, Wt %				
Moisture			1.86	2.95
C			71.03	68.14
H			2.50	4.65
S			1.45	0.50
Ash + SO_3			16.46	6.27
Elemental Analysis, Wt %				
SiO_2	3.52		34.04	17.72
SO_3	0.10		21.83	12.37
Na_2O	0.02		1.25	1.04
CaO	93.06		20.83	39.27
MgO	2.12		5.99	10.63
K_2O	0.03		0.31	0.20
P_2O_5	0.03		0.04	0.23
Al_2O_3	0.85		9.66	12.93
Fe_2O_3	0.35		6.01	5.59
TiO_2	0.02		0.34	0.34

Table 28-6. FEEDSTOCK COMPOSITES, RUN 28B

Date	← 8/30/75 →				← 8/31/75 →			9/1/75	
Time	0000	0800	1600	2400	0800	1600	2400	0800	1600
Screen Size, Wt % Tyler Mesh									
+4									
4 X 6					1.4			0.7	
6 X 8					3.9			6.1	
8 X 9	1.0	0.9	1.4	1.1	4.5	7.4	17.2	11.2	20.1
9 X 10					18.6			23.3	
10 X 12	39.9	40.0	48.5	47.1	31.6	43.2	40.7	27.4	40.3
12 X 14					25.2			19.9	
14 X 16					11.4			8.0	
16 X 20	57.8	57.6	47.1	50.0	2.1	43.8	38.3	1.4	30.5
20 X 24					0.2			0.4	
24 X 28	1.2	1.3	1.2	1.1	Tr	1.9	2.1	0.3	3.7
-28	0.2	0.1	1.8	0.7	1.0	3.6	1.7	1.2	5.4

Table 28-7. CIRCULATED ACCEPTOR, CALCINED ACCEPTOR, RUN 28A

Date	← 9/15/75 →			← 9/16/75 →			← 9/17/75 →			← 9/18/75 →		
Time	0800	1600	2400	0800	1600	2400	0800	1550	2400	0800	1600	2000
Screen Size, Wt %												
Tyler Mesh												
+4												
4 X 6				0.1			0.3			0.4		
6 X 8	0.4			1.3			4.6			10.2		
8 X 9	0.9	0.9	1.5	1.5	5.1	9.5	6.5	22.8	21.2	12.0	31.2	17.0
9 X 10	13.2			16.6			18.9			24.8		
10 X 12	38.2	42.7	53.9	37.3	47.7	48.5	27.7	46.5	48.8	22.6	44.2	45.2
12 X 14	27.2			26.8			23.7			17.8		
14 X 16	13.7			11.6			10.5			5.6		
16 X 20	3.3	51.8	42.0	2.1	44.3	39.5	2.6	28.0	25.9	2.3	20.2	27.3
20 X 24	1.3			0.6			1.2			1.3		
24 X 28	0.4	1.8	0.8	0.3	0.1	1.7	0.7	1.7	2.1	1.1	2.7	5.5
-28	1.3	2.8	1.9	1.8	2.8	0.8	3.3	1.1	1.9	1.8	1.7	5.0
% Calcine Weight Change	-0.1			-1.2			-0.5			-0.6		
Elemental Analysis, Wt %												
S=	0.03			0.03			0.04			0.03		
SiO_2	1.26			3.21			2.98			3.82		
SO_3				0.04			0.05			0.06		

Table 28-8. CIRCULATED ACCEPTOR, CALCINED ACCEPTOR, RUN 28B (Sheet 1 of 3)

Date	← 9/19/75 →			← 9/20/75 →			← 9/21/75 →			← 9/22/75 →		
Time	0800	1610	2405	0800	1600	2430	0800	1600	2415	0800	1600	2415
Screen Size, Wt %												
Tyler Mesh												
+4												
4 X 6	0.2			0.2			0.1			0.3		
6 X 8	6.5			14.2			12.5			18.7		
8 X 9	12.9	32.6	29.4	20.1	32.0	36.2	22.9	28.6	31.4	22.2	46.0	35.7
9 X 10	26.7			23.5			23.2			17.9		
10 X 12	21.0	40.7	39.0	14.8	35.6	36.0	14.8	33.8	29.1	12.1	25.4	25.5
12 X 14	15.3			7.6			8.9			7.8		
14 X 16	5.0			3.4			4.7			4.6		
16 X 20	3.3	17.8	20.0	3.4	17.3	16.9	4.2	20.3	19.0	3.8	13.9	16.5
20 X 24	2.5			3.2			3.1			3.0		
24 X 28	2.8	5.7	8.4	4.0	10.6	7.5	3.0	11.3	13.0	3.1	9.3	11.0
-28	3.8	3.3	3.1	5.6	4.6	3.4	2.8	6.1	7.5	3.6	5.4	11.4
% Calcine Weight Change				-0.8			-0.3			-1.5		
Elemental Analysis, Wt %												
S=				0.12			0.11			0.06		
SiO_2				6.85			5.83			5.49		
SO_3				0.43			0.35			0.18		

Table 28-8. CIRCULATED ACCEPTOR, CALCINED ACCEPTOR, RUN 28B (Sheet 2 of 3)

Date	← 9/23/75 →			← 9/24/75 →			← 9/25/75 →			← 9/26/75 →		
Time	0800	1600	2415	0800	1600	2430	0800	1600	2415	0800	1600	2400
Screen Size, Wt %												
Tyler Mesh												
+4												
4 X 6	0.8		0.6				0.2			0.5		
6 X 8	30.6		21.6	28.5			24.2			24.7		
8 X 9	18.9	66.3	22.5	22.7	62.1	59.2	18.5	44.5	37.6	21.3	42.7	44.3
9 X 10	14.9		18.1	17.6			14.8			17.3		
10 X 12	7.9	23.5	10.6	8.7	2.5	3.8	9.2	25.1	27.2	11.1	27.2	28.9
12 X 14	5.8		6.6	7.9			7.4			7.6		
14 X 16	4.1		3.9	3.1			5.1			4.9		
16 X 20	3.7	6.6	3.3	2.7	14.3	16.7	4.4	14.7	14.8	4.1	13.4	12.7
20 X 24	3.3		2.7	2.1			3.5			3.2		
24 X 28	3.8	2.1	3.1	2.3	8.8	11.5	4.3	9.3	10.3	3.8	10.0	8.1
-28	6.1	1.6	7.2	3.6	13.1	8.7	8.4	6.4	10.2	1.4	6.7	6.0
% Calcine Weight Change	-1.1		-1.6				-0.5			-1.3		
Elemental Analysis, Wt %												
S=	0.05		0.10				0.11			0.11		
SiO_2	6.64		6.26				6.78			6.68		
SO_3	0.14		0.16				0.20			0.23		

Table 28-8. CIRCULATED ACCEPTOR, CALCINED ACCEPTOR, RUN 28B (Sheet 3 of 3)

Date	← 8/30/75 →				← 8/31/75 →			9/1/75	
Time	0030	0800	1600	2400	0800	1600	2400	0800	1600
Screen Size, Wt %									
Tyler Mesh									
+4						0.2		0.4	
4 X 6					1.3	2.5		3.8	
6 X 8					3.1	3.8	9.1	8.4	21.1
8 X 9	0.7	1.2	0.8	0.8	16.2	15.5		23.2	
9 X 10					29.4	23.8	43.7	26.8	43.7
10 X 12	35.0	43.5	36.7	41.2	30.4	24.8		25.9	
12 X 14					16.0	12.7		9.7	
14 X 16					3.1	15.2	45.3	1.7	32.4
16 X 20	62.6	54.4	57.7	56.6	0.3	0.8		Tr	
20 X 24					Tr	0.3	1.5	Tr	2.1
24 X 28	1.5	0.9	1.3	1.3	0.1	0.4	0.4	Tr	0.8
-28	0.2	Tr	3.5	0.2					
Particle Density, lb/cu ft			204	194	188	169	162	160*	
% Calcine Weight Change			-1.0	-1.4	-1.8	-4.91	-6.2	-6.6	-6.6
Activity						0.08	0.08	0.08	0.09
Elemental Analysis, Wt %									
SiO_2			2.06	2.45	1.84	2.05	2.97	2.52	
SO_3			0.20	0.15	0.11	0.08	0.12	0.20	
Na_2O					0.03	0.03	0.03	0.03	
CaO					59.91	64.92	65.82	68.27	
MgO					35.78	30.63	28.34	20.49	
K_2O					0.01	0.02	0.01	0.01	
P_2O_5					0.01	0.03	0.03	0.03	
Al_2O_3					1.75	1.33	1.46	1.64	
Fe_2O_3					1.25	1.27	1.43	1.08	
TiO_2					0.05	0.01	0	0	

*1200 Hours Sample

Table 28-9. CIRCULATED ACCEPTOR, RECARBONATED ACCEPTOR, RUN 28A

Date	← 9/15/75 →			← 9/16/75 →			← 9/17/75 →			← 9/18/75 →		
Time	0800	1600	2400	0800	1600	2400	0800	1600	2400	0800	1600	2000
Screen Size, Wt %												
Tyler Mesh												
+4												
4 X 6												
6 X 8	0.3			0.2			1 2			0.1		
8 X 9	1.9	0.8	1.0	0.4			4.5			6.0		
9 X 10	11.0			1.4	8.1	9.5	7.3	14.4	18.5	10.9	25.1	21.1
10 X 12	34.6	44.2	50.2	12.9			19.7			26.6		
12 X 14	29.5			37.9	46.1	48.5	28.9	50.5	48.0	25.2	51.6	48.1
14 X 16	15.9			29.4			23.5			19.5		
16 X 20	3.3	54.2	48.4	14.8			9.3			5.7		
20 X 24	3.0			2.6	44.8	39.5	2.2	33.5	30.1	2.3	21.7	25.0
24 X 28	0.4	0.7	0.4	0.4			2.1			1.1		
-28	0	0.1	0	0.1	0.8	1.7	0.7	1.5	2.5	1.1	1.4	4.1
				0.1	0.1	0.8	0.7	0.1	0.9	1.4	0.1	1.8
Particle Density, lb/cu ft					186.4		176	164	143	156	146	
% Calcine Weight Change	-1.3			-1.2	-5.4		-6.4			-8.3		
Activity					0.06		0.10	0.09	0.10	0.11	0.12	
Elemental Analysis, Wt %												
S=	0.10				0.01		0.06			0.07		
SiO_2	1.07			1.58			2.77			3.00		
SO_3^2				0.09			0.14			0.23		

Table 28-10. CIRCULATED ACCEPTOR, RECARBONATED ACCEPTOR, RUN 28B (Sheet 1 of 3)

Date	← 9/19/75 →			← 9/20/75 →			← 9/21/75 →			← 9/22/75 →		
Time	0815	1545	2355	0800	1550	2400	0800	1600	2400	0800	1640	
Screen Size, Wt % Tyler Mesh												
+4												
4 X 6	0.1						0.1			0.1		
6 X 8	7.9			13.8			15.6			17.1		
8 X 9	16.6	31.6	32.1	22.3	42.5	37.0	24.9	50.0	49.8	26.7	48.6	54.5
9 X 10	31.6			24.1			25.2			26.0		
10 X 12	22.7	44.0	44.2	14.9	39.7	41.6	15.3	35.2	36.5	14.7	30.7	30.0
12 X 14	14.4			8.0			8.2			8.5		
14 X 16	3.6			9.6			3.8			3.7		
16 X 20	1.7	20.6	19.9	2.5	14.8	17.6	2.6	12.3	11.4	1.9	12.1	11.4
20 X 24	0.7			1.6			1.5			0.8		
24 X 28	0.3	3.3	3.3	1.3	2.7	3.4	1.2	2.0	1.8	0.4	3.2	2.9
-28	0.3	0.5	0.5	2.1	0.3	0.5	1.6	0.4	0.4	0.2	5.5	1.1
Particle Density, lb/cu ft	154	143	139	132	126	127	128	133	126	128	126	128
% Calcine Weight Change							-10.2			-10.6		
Activity	0.15	0.12	0.16	0.12	0.14	0.14	0.10	0.15	0.15	0.14	0.17	0.14
Elemental Analysis, Wt %												
S=				0.08			0.03			0.09		
SiO_2				5.45			5.62			4.84		
SO_3				0.58			0.45			0.35		

Table 28-10. CIRCULATED ACCEPTOR, RECARBONATED ACCEPTOR, RUN 28B (Sheet 2 of 3)

Date	← 9/23/75 →			← 9/24/75 →			← 9/25/75 →			← 9/26/75 →		
Time	0800	1640	2400	0845	1600	2340	0800	1600	2415	0800	1600	2400
Screen Size, Wt % Tyler Mesh												
+4												
4 X 6	0.2		1.1	0.3			0.5			0.5		2.8
6 X 8	26.7		39.8	28.4			29.7			29.9		24.3
8 X 9	26.4	59.0	29.0	25.8	88.2	80.3	24.6	50.8	47.7	24.9	49.2	22.5
9 X 10	20.6		16.5	18.9			17.7			17.7		17.4
10 X 12	9.4	26.5	4.7	10.6	1.7	3.7	10.3	28.1	31.7	11.1	26.8	9.2
12 X 14	6.0		2.4	6.8			7.2			7.3		6.2
14 X 16	3.1		2.2	3.8			3.9			4.0		4.8
16 X 20	2.3	10.7	1.3	2.8	7.0	11.3	2.4	13.1	13.6	2.3	13.0	2.9
20 X 24	1.5		1.8	1.4			1.6			1.3		7.3
24 X 28	1.3	2.9	0.6	0.8	2.3	3.4	1.0	4.5	4.3	0.6	5.3	1.1
-28	2.5	0.8	0.6	0.4	0.8	1.3	1.0	3.5	2.7	0.3	5.7	1.6
Particle Density, lb/cu ft	121	121	122	125	128	125	126	127	125	124	128	127
% Calcine Weight Change	-8.9		-8.1				-9.0			-8.6		-9.0
Activity	0.17	0.11	0.12	0.16		0.12	0.13	0.12	0.12	0.13	0.10	0.13
Elemental Analysis, Wt %												
S=	0.05		0.01				0.06			0.02		0.04
SiO_2	4.97		5.14				6.00			5.86		6.37
SO_3	0.27		0.27				0.25			0.27		0.33

Table 28-10. CIRCULATED ACCEPTOR, RECARBONATED ACCEPTOR, RUN 28B (Sheet 3 of 3)

Date	← 8/30/75 →				← 8/31/75 →						← 9/1/75 →			
Time	1200		2000		0400		1200		2000		0400		1200	
Sample	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor
Screen Size, Wt %														
Tyler Mesh														
+8			0.2		1.2	1.0	0.7	3.9	1.7	3.9	2.7	5.4	1.7	7.1
8 X 9		0.7				1.8		3.5		5.7		7.6		9.7
9 X 10	2.4		3.1		3.1		5.5		5.6		8.9		9.4	
10 X 12		40.2		40.0		40.3		40.5		43.5		37.6		33.9
12 X 14	23.2	22.7	29.0	22.5	32.6	24.0	22.4	21.1	28.2	19.9	27.9	18.1	21.3	15.8
14 X 20	16.9	27.1	13.9	21.6	14.4	19.5	13.0	18.5	11.9	15.6	12.0	11.9	10.9	12.4
20 X 28	13.5	2.1	7.3	2.2	6.8	1.8	9.7	2.3	7.5	2.5	9.4	3.4	11.3	4.2
28 X 35	15.0		11.5		10.0		12.7		10.1		10.4		13.5	
35 X 48	13.5		9.9		8.8		12.1		11.9		7.2		14.0	
48 X 65	7.2	6.7	12.4	12.3	11.1	7.3	11.1	9.9	8.9	8.9	10.6	9.9	8.2	11.9
65 X 80		0.4				4.2		0.2		0.1		6.1		5.1
80 X 100	5.5		7.8		6.9		8.2		7.8		5.9		7.1	
100 X 200	2.5		4.3		4.1		4.3		5.1		3.6		2.6	
-200	0.3		0.4	1.4	1.0		0.4	0.2	1.3		1.1			
% Char	54.7		60.0		47.0		57.9		52.4		55.9		60.3	
% Ash + SO_3	18.47		16.71		17.92		15.46		16.08		13.19		14.69	
Ash Elemental Analysis, Wt %														
SiO_2	25.68		22.21		26.58		19.68		22.88		18.52		17.56	
SO_3	8.00		3.32		4.28		2.80		2.75		2.57		2.09	

Table 28-11. GASIFIER CHAR BED MATERIAL, RUN 28A

Date	← 9/15/75 →			← 9/16/75 →				← 9/17/75 →					
Time	0040		2400	1200		2000		0040		1200		2000	
Sample	Mix	Acceptor	Mix	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor
Screen Size, Wt %													
Tyler Mesh													
+8				0.7	2.9	1.6	3.9	1.1	2.6	3.5	8.2	3.5	8.6
8 X 9					3.0		2.4		6.7		14.9		13.5
9 X 10	0.6		3.4	3.3		5.3		5.3		10.7		12.7	
10 X 12		39.0			25.8		48.4		39.4		5.6		44.7
12 X 14	15.0	16.8	26.2	28.5	26.6	22.0	18.9	19.7	13.8	32.9	24.7	24.8	13.3
14 X 20	13.6	16.4	13.8	13.5	24.9	10.8	11.4	9.3	11.0	10.7	18.4	10.8	5.0
20 X 28	15.5	2.7	12.1	9.8	2.9	9.7	2.6	9.9	3.4	8.2	6.7	10.1	3.2
28 X 35	15.9		13.4	12.6		12.3		13.0		9.9		10.9	
35 X 48	15.3		8.0	10.6		10.3		9.3		1.0		10.6	
48 X 65	10.0	13.1	12.5	10.6	12.4	12.8	11.8	16.2	15.7	16.3	20.9	7.7	8.0
65 X 80		12.0			1.2		0.6		7.5		0.7		0.6
80 X 100	7.6		6.3	6.6		8.5		9.7		5.0		6.1	
100 X 200	4.8		3.6	3.3		5.1		5.5		1.6		2.4	
-200	1.9		0.4	0.5	0.4	1.6		1.1	Tr			0.3	0.1
% Char	82.6		55.5	52.2		63.6		69.1		50.5		52.0	
% Ash + SO_3	16.22		23.95	17.0		16.82		14.48		13.27		13.60	
Ash Elemental Analysis, Wt %													
SiO_2								16.98					
SO_3								2.95					
Na_2O								1.41					

Table 28-12. GASIFIER CHAR BED MATERIAL, RUN 28B (Sheet 1 of 6)

Date	← 9/18/75 →						← 9/19/75 →					
Time	0400		1200		2000		0400		1200		2000	
Sample	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor
Screen Size, Wt %												
Tyler Mesh												
+8	3.2	10.5		7.8	4.4	11.6	3.3	8.5	4.2	9.8	4.6	8.5
8 X 9		11.6		10.0		16.3		14.3		18.2		18.1
9 X 10	11.8		14.3		14.9		13.2		17.7		20.2	
10 X 12		43.4		40.3		41.0		35.8		38.1		35.7
12 X 14	24.4	11.7	25.7	11.3	21.4	8.8	19.2	9.1	19.7	5.4	18.7	6.3
14 X 20	8.3	7.4	7.2	7.5	7.4	6.8	8.6	7.7	7.3	7.7	6.5	7.0
20 X 28	8.5	4.4	7.8	5.5	8.4	4.6	11.3	6.4	9.5	6.9	8.3	6.5
28 X 35	10.7		10.5		11.0		13.1		11.5		10.7	
35 X 48	6.2		5.5		12.4		9.3		8.1		9.4	
48 X 65	15.2	10.8	16.7	13.7	8.9	10.4	12.8	15.2	12.0	13.3	11.1	16.7
65 X 80		0.4		3.9		0.5		3.0		0.6		1.0
80 X 100	7.7		8.1		7.5		6.5		6.7		6.9	
100 X 200	3.4		3.5		3.2		2.4		3.0		2.9	
-200	0.7		0.7	Tr	0.5		0.2		0.3	Tr	0.7	0.1
% Char	50.9		51.0		43.8		54.3		42.2		41.7	
% Ash + SO_3	13.70		14.05		14.37		13.95		15.06		14.8	
Ash Elemental Analysis, Wt %												
SiO_2	17.01				15.72							
SO_3	2.21				1.86							
Na_2O	1.42				1.53							

Table 28-12. GASIFIER CHAR BED MATERIAL, RUN 28B (Sheet 2 of 6)

Date	← 9/20/75 →						← 9/21/75 →					
Time	0400		1200		2000		0430		1200		2000	
Sample	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor
Screen Size, Wt %												
Tyler Mesh												
+8	0.1	11.0	6.6	12.8	5.8	17.0	9.2	12.8	6.2	11.7	9.0	21.9
8 X 9		20.5		20.0		19.0		23.8		17.2		25.2
9 X 10	19.7		20.0		17.9		23.5		17.4		22.2	
10 X 12		31.0		31.1		28.9		28.8		28.1		28.2
12 X 14	21.1	7.1	16.7	6.4	14.2	5.4	17.5	6.0	13.9	6.7	14.8	4.4
14 X 20	7.3	7.9	6.5	8.4	7.8	7.2	8.5	7.1	7.7	8.5	8.4	5.9
20 X 28	8.6	7.2	7.1	6.4	9.2	6.0	8.9	6.9	9.1	8.7	9.5	4.6
28 X 35	10.8		9.1		11.3		9.5		10.7		10.0	
35 X 48	10.5		11.8		12.8		3.3		4.0		2.8	
48 X 65	11.2	13.5	8.4	14.0	9.4	15.9	13.1	11.9	18.5	18.2	14.3	9.0
65 X 80		1.2		0.8		0.6		2.7		1.0		0.8
80 X 100	7.5		7.6		7.8		4.8		7.8		5.9	
100 X 200	2.9		4.3		3.2		1.7		3.6		2.4	
-200	0.2	0.6	2.0	Tr	0.5	Tr		Tr	1.0	Tr	0.8	Tr
% Char	43.7		44.4		46.3		37.6		52.0		44.6	
% Ash + SO_3	17.30		16.96		14.79		12.14		15.45		12.48	
Ash Elemental Analysis, Wt %												
SiO_2	17.56						12.42					
SO_3	2.91						2.35					
Na_2O	1.28						1.31					

Table 28-12. GASIFIER CHAR BED MATERIAL, RUN 28B (Sheet 3 of 6)

Date	← 9/22/75 →						← 9/23/75 →					
Time	0400		1200		2000		0400		1200		2000	
Sample	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Accepto
Screen Size, Wt % Tyler Mesh												
+8	11.0	22.1	8.5	18.0	10.7	22.3	6.8	24.7	10.1	18.8	11.8	21.4
8 X 9		24.0		20.4		26.3		24.0		24.7		22.5
9 X 10	23.7		20.0		22.3		16.0		16.8		20.6	
10 X 12		28.2		25.7		26.0		22.9		23.3		23.8
12 X 14	15.2	4.5	14.7	4.9	15.4	5.4	12.7	5.3	12.4	5.8	13.3	5.6
14 X 20	7.6	6.2	7.2	7.0	9.2	5.8	8.9	7.1	7.0	6.9	9.3	7.3
20 X 28	8.4	5.4	8.2	7.2	9.9	4.4	10.9	5.5	9.1	6.6	10.5	6.0
28 X 35	8.9		9.8		9.7		12.2		10.9		10.3	
35 X 48	9.9		8.5		9.8		6.1		7.0		5.0	
48 X 65	6.6	9.3	11.2	15.8	5.7	8.0	14.0	10.1	13.3	12.5	10.0	11.1
65 X 80		0.4		1.1		1.1		0.5		1.1		1.5
80 X 100	6.2		7.9		5.6		9.5		9.3		6.9	
100 X 200	2.3		3.1		1.6		2.5		3.3		2.2	
-200	0.2	Tr	1.0	Tr	0.1	0.7	0.4	Tr	0.8	0.3	0.2	0.8
% Char	42.1		46.4				49.4		53.6		46.8	
% Ash + SO_3	12.81		16.16				13.36		13.90		14.18	
Ash Elemental Analysis, Wt % SiO_2	12.24						14.73		12.61			
SO_3	1.85						2.29		2.29			
Na_2O	1.43						1.71		1.56			

Table 28-12. GASIFIER CHAR BED MATERIAL, RUN 28B (Sheet 4 of 6)

Date	← 9/24/75 →				← 9/25/75 →					
Time	1200		2000		0400		1200		200	
Sample	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor
Screen Size, Wt %										
Tyler Mesh										
+8	11.4	23.3	9.4	22.6	12.6	24.3	13.1	25.6	7.3	19.9
8 X 9		20.8		16.8		23.1		20.6		19.0
9 X 10	16.8		14.8		17.7		20.4		14.0	
10 X 12		21.1		21.3		20.9		22.7		22.6
12 X 14	11.2	3.9	10.3	6.1	9.9	4.3	12.2	5.3	9.4	4.7
14 X 20	7.9	7.9	7.5	7.3	7.0	6.4	8.5	6.7	8.4	7.0
20 X 28	10.7	7.6	10.5	8.2	9.1	5.4	9.6	5.8	11.2	6.6
28 X 35	11.8		12.7		11.2		10.2		13.0	
35 X 48	8.0		0.5		5.7		9.5		10.4	
48 X 65	11.1	14.8	19.5	16.9	10.1	15.2	9.4	11.2	15.3	17.5
65 X 80		0.3		0.7		0.4		0.8		1.6
80 X 100	7.2		11.5		13.8		5.3		8.2	
100 X 200	3.0		3.1		2.8		1.8		2.5	
-200	1.0	0.3	0.2	0.1	Tr	0	Tr	1.2	0.4	1.0
% Char	54.1		54.3		47.5		39.9		58.7	
% Ash + SO_3	19.27		14.08		12.91		11.75		13.71	
Ash Elemental Analysis, Wt %										
SiO_2					14.49					
SO_3					3.78					
Na_2O					1.47					

Table 28-12. GASIFIER CHAR BED MATERIAL, RUN 28B (Sheet 5 of 6)

Date	← 9/26/75 →						9/27/75	
Time	0400		1200		2000		0400	
Sample	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor
Screen Size, Wt %								
Tyler Mesh								
+8	10.6	17.8	7.9	21.0	11.2	25.6	8.7	18.6
8 X 9		22.4		22.9		20.4		20.4
9 X 10	16.2		13.8		14.5		14.0	
10 X 12		25.1		21.0		22.6		26.3
12 X 14	10.8	5.4	11.8	4.8	11.4	4.7	15.1	6.5
14 X 20	6.9	8.1	10.1	8.2	7.4	7.5	8.5	8.2
20 X 28	8.7	6.3	11.0	7.4	9.6	5.2	10.4	6.9
28 X 35	10.8		11.5		11.8		12.0	
35 X 48	5.2		7.0		1.6		10.2	
48 X 65	18.4	13.7	14.8	13.3	22.5	13.1	11.2	12.2
65 X 80		1.1		0.8		0.8		0.7
80 X 100	7.8		7.1		7.4		5.9	
100 X 200	3.8		3.4		2.1		2.7	
-200	0.9	Tr	1.5	0.5	0.4	0.1	1.2	0.3
% Char	51.2		52.7		52.4		52.1	
% Ash + SO_3	13.80		15.49		12.80		13.57	
Ash Elemental Analysis, Wt %								
SiO_2	15.06						13.88	
SO_3	2.74						2.20	
Na_2O	1.17						1.17	

Table 28-12. GASIFIER CHAR BED MATERIAL, RUN 28B (Sheet 6 of 6)

Date	8/30/75		← 8/31/75 →						← 9/1/75 →			
Time	2330		0805		1415		2400		0935		1445	
Sample	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor
Screen Size, Wt % Tyler Mesh												
+8				0.2	2.0	2.4	2.6	3.3	3.8	5.2	1.2	6.0
8 X 9				1.1		4.6		6.9		9.9		8.6
9 X 10	2.5		7.6		9.9		9.8		14.0		4.1	
10 X 12		38.9		40.5		45.5		37.6		38.6		36.4
12 X 14	34.5	25.6	41.3	23.3	39.3	20.7	33.9	20.7	32.7	18.4	10.3	10.3
14 X 20	17.1	21.8	16.5	23.4	15.9	19.4	12.7	16.1	10.2	11.8	5.9	8.9
20 X 28	7.6	1.8	4.4	1.9	5.7	2.1	7.4	3.1	7.0	4.2	7.3	4.3
28 X 35	11.5		8.1		7.5		10.6		11.0		9.7	
35 X 48	9.6		9.7		2.7		7.0		4.5		10.6	
48 X 65	10.0	6.8	6.7	7.7	11.3	5.2	10.7	9.1	12.6	11.7	7.4	16.8
65 X 80		4.8		2.0				3.3				8.6
80 X 100	5.3		4.3		4.0		4.0		3.2		5.8	
100 X 200	1.9		1.3		1.7		1.3		0.9		37.8	
-200		0.2				0.1				0.1		
% Char	44.0		33.3		28.0		37.0		36.3		74.1	
% Ash + SO_3	16.46		15.68		13.98		13.73		13.98		15.1	
Ash Elemental Analysis, Wt % SiO_2	22.78		23.72		20.37		19.95		19.32		16.92	
SO_3	2.66		2.39		2.62		3.11		2.99		1.84	

Table 28-13. PURGED FUEL CHAR MATERIAL, RUN 28A

Date	9/15/75		← 9/16/75 →						← 9/17/75 →					
Time	1030		0150		0600		1620		0245		0850		1445	
Sample	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor
Screen Size, Wt %														
Tyler Mesh														
+8							1.4		1.5	4.1	2.6	4.0	1.6	4.4
8 X 9			0.8		1.8			3.4		7.6		6.2		10.8
9 X 10	1.8		2.1		3.6		5.8		6.4		9.2		9.8	
10 X 12		7.4		39.8		41.3		16.6		40.0		40.1		17.5
12 X 14	24.3	77.3	43.0	27.8	42.8	27.4	35.6	31.1	25.9	15.7	26.6	15.2	27.1	23.0
14 X 20	15.0		14.8	21.8	15.8	19.6	13.5	23.3	13.3	14.2	10.8	12.5	12.1	18.7
20 X 28	15.8	2.7	8.4	1.7	8.5	1.7	9.2	3.9	12.0	3.3	10.1	5.3	11.7	7.0
28 X 35	17.4		10.3		10.5		13.6		13.6		13.5		14.2	
35 X 48	9.4		10.0		6.9		9.7		9.3		5.0		8.0	
48 X 65	11.1	5.6	6.0	7.7	7.7	7.9	7.3	16.8	11.0	11.4	16.3	15.9	11.5	14.0
65 X 80		7.0		0.3		0.3		5.0		3.7		0.8		4.6
80 X 100	3.9		3.6		3.1		3.0		5.2		4.6		3.4	
100 X 200	1.3		1.4		1.1		1.0		1.9		1.3		0.5	
-200	Tr		0.2			Tr			Tr		Tr		Tr	Tr
% Char	66.6		41.9		38.1		45.4		56.7		55.8		41.2	
% Ash + SO_3	15.80		27.57		15.94		16.15		7.77		10.88		12.49	
Ash Elemental Analysis, Wt %														
SiO_2					24.52				15.06					
SO_3					12.48				3.28					
Na_2O					1.33				1.34					

Table 28-14. PURGED FUEL CHAR MATERIAL, RUN 28B (Sheet 1 of 6)

Date	← 9/18/75 →								← 9/19/75 →			
Time	0155		0630		1800		2330		0815		1630	
Sample	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor
Screen Size, Wt % Tyler Mesh												
+8	2.1	4.4	2.0	3.6	2.5	5.5	2.9	4.3	4.9	14.8	6.0	14.5
8 X 9		7.7		12.5		9.7		13.3		20.2		20.3
9 X 10	9.7		8.0		10.7		13.6		18.6		20.5	
10 X 12		32.4		39.2		35.7		36.1		30.3		35.4
12 X 14	23.8	12.0	21.5	12.0	25.6	13.0	24.8	12.2	23.3	8.5	22.3	6.7
14 X 20	8.9	9.1	9.5	8.4	9.9	9.5	9.5	10.5	10.2	6.9	8.6	6.6
20 X 28	11.3	5.8	11.4	6.3	11.7	7.1	11.7	7.0	12.7	5.6	9.4	5.7
28 X 35	15.7		14.1		14.9		14.4		12.5		12.4	
35 X 48	10.6		11.0		13.0		11.5		7.0		10.4	
48 X 65	12.0	27.4	10.6	17.8	7.2	15.9	7.7	16.2	8.0	9.3	6.9	10.5
65 X 80		i.1		0.2		3.5		0.4		4.4		0.2
80 X 100	4.8		5.3		3.7		3.3		2.4		3.2	
100 X 200	1.0		6.5		0.8		0.6		0.4		0.4	
-200			Tr				Tr	Tr			Tr	Tr
% Char	54.3		58.0		43.8		44.0		44.0		34.9	
% Ash + SO_3	11.27		12.49		12.74		12.59		11.28		16.8	
Ash Elemental Analysis, Wt % SiO_2			12.35				13.58					
SO_3			2.36				2.28					
Na_2O			1.22				1.15					

Table 28-14. PURGED FUEL CHAR MATERIAL, RUN 28B (Sheet 2 of 6)

Date	← 9/20/75 →								← 9/21/75 →					
Time	0145		0630		1535		2350		0800		1730		2250	
Sample	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor
Screen Size, Wt %														
Tyler Mesh														
+8	5.7	8.7	7.9	13.8	9.8	9.1	6.5	11.0	9.6	10.8	12.3	14.0	7.8	14.9
8 X 9		17.8		20.4		18.8		18.7		18.2		25.7		23.3
9 X 10	22.1		24.6		33.8		22.1		26.6		29.0		24.1	
10 X 12		34.1		29.9		34.2		33.8		13.4		33.1		29.8
12 X 14	23.9	7.0	21.5	6.7	23.9	8.1	20.2	6.8	20.9	23.7	15.5	6.3	18.9	6.1
14 X 20	7.2	8.7	8.4	8.0	8.0	10.0	8.7	9.3	8.0	9.7	6.9	6.4	9.0	9.0
20 X 28	8.2	9.6	8.7	7.0	7.2	7.3	9.4	8.1	9.0	9.5	8.9	5.3	10.3	7.8
28 X 35	10.8		9.9		7.0		10.9		9.1		9.4		11.1	
35 X 48	7.5		10.2		6.3		7.6				7.8		1.0	
48 X 65	10.3	13.5	4.9	12.9	2.6	11.9	9.8	11.8	13.4	14.1	6.1	8.8	14.6	8.6
65 X 80		0.5		1.2		0.6		0.3		0.6		0.3		0.4
80 X 100	3.6		3.2		1.4		4.0		2.4		3.4		2.8	
100 X 200	0.7		0.7				0.9		0.4		0.7		0.4	
-200		0.1	Tr	Tr		0.2			0,1					
% Char	28.6		32.8		27.2		32.3		29.2		38.2		28.8	
% Ash + SO_3	11.2		16.3		12.57		10.70		12.42		12.33		7.78	
Ash Elemental Analysis, Wt %														
SiO_2			17.74											
SO_3			2.49											
Na_2O			1.66											

Table 28-14. PURGED FUEL CHAR MATERIAL, RUN 28B (Sheet 3 of 6)

Date	← 9/22/75 →						← 9/23/75 →					
Time	0820		1510		2240		0730		1610		2400	
Sample	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor
Screen Size, Wt %												
Tyler Mesh												
+8	7.9	11.1	13.4	19.7	11.1	15.9	5.9	12.8	11.5	20.1	10.9	20.4
8 X 9		22.6		23.6		23.6		20.9		21.8		20.8
9 X 10	25.0		30.2		26.5		15.8		21.9		22.2	
10 X 12		31.4		28.2		30.2		26.5		23.7		25.7
12 X 14	18.3	6.6	17.7	6.3	18.2	6.2	16.7	7.2	13.9	5.6	14.8	5.7
14 X 20	9.6	8.7	7.8	7.9	8.6	7.5	9.7	8.0	7.8	7.6	8.0	7.7
20 X 28	11.0	6.9	8.5	6.0	9.4	5.8	12.6	8.5	10.6	7.3	10.1	6.6
28 X 35	10.4		8.2		9.6		15.1		12.1		11.3	
35 X 48	8.6		7.4		2.8		8.6		4.0		9.9	
48 X 65	5.0	11.6	4.0	7.6	9.0	9.5	9.4	14.9	13.4	13.2	8.2	11.5
65 X 80		1.1		0.5		0.8		0.9		0.5		0.9
80 X 100	3.5		2.5		4.4		5.8		4.5		4.0	
100 X 200	0.6		0.3		0.5		0.5		0.4		0.6	
-200			Tr		Tr	0.4		0.3		0.2		0.6
% Char	43.9		25.5		31.5		45.4		37.0		36.7	
% Ash + SO_3	10.53		10.24		6.14		12.39		12.85		11.48	
Ash Elemental Analysis, Wt %												
SiO_2							11.00					
SO_3							2.49					
Na_2O							1.15					

Table 28-14. PURGED FUEL CHAR MATERIAL, RUN 28B (Sheet 4 of 6)

Date	← 9/24/75 →						← 9/25/75 →					
Time	0915		1630		2215		0635		1710		2230	
Sample	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor
Screen Size, Wt % Tyler Mesh												
+8	1.4	11.0	17.2	24.9	13.6	20.4	12.3	14.4	12.4	18.5	10.3	16.1
8 X 9		17.0		20.7		22.9		20.8		21.9		17.6
9 X 10	3.1		29.4		25.5		22.0		21.5		21.8	
10 X 12		19.7		24.4		26.1		27.6		27.0		25.5
12 X 14	3.2	5.0	17.1	5.5	17.4	5.9	13.4	6.8	13.4	5.8	15.6	6.4
14 X 20	4.4	7.7	7.4	7.5	8.0	7.8	8.9	9.8	7.8	8.2	8.5	9.6
20 X 28	7.3	8.3	7.5	5.9	9.0	6.2	11.6	7.5	10.2	6.1	9.6	8.2
28 X 35	9.0		7.7		9.2		11.9		12.2		11.0	
35 X 48	56.0		5.7		4.5		7.3		8.6		8.0	
48 X 65	8.8	27.3	4.1	10.7	6.2	10.4	9.3	12.5	9.8	12.1	10.8	16.2
65 X 80		3.0		0.4		0.4		0.5		0.4		0.4
80 X 100	5.7		3.1		5.9		2.8		3.4		3.5	
100 X 200	1.1		0.5		0.8		0.5		0.6		0.7	
-200		1.0			Tr	0.1	Tr	Tr	Tr	Tr		Tr
% Char	76.4		20.6		28		40.7		39.2		34.0	
% Ash + SO_3	14.37		12.64		11.72		13.92		13.83		12.19	
Ash Elemental Analysis, Wt %												
SiO_2							14.30					
SO_3							3.53					
Na_2O							1.18					

Table 28-14. PURGED FUEL CHAR MATERIAL, RUN 28B (Sheet 5 of 6)

Date	← 9/26/75 →						9/27/75	
Time	0800		1700		2330		0535	
Sample	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor
Screen Size, Wt %								
Tyler Mesh								
+8	11.0	19.8	6.6	14.5	4.6	21.3	10.8	19.7
8 X 9		19.3		20.8		19.0		20.3
9 X 10	20.1		14.8		62.0		21.2	
10 X 12		26.3		25.6		23.1		26.3
12 X 14	15.5	6.5	14.8	6.0	6.0	5.4	17.1	5.5
14 X 20	7.4	8.5	9.8	9.2	3.7	8.5	8.1	9.0
20 X 28	9.8	6.4	13.5	6.3	5.3	7.3	9.6	6.9
28 X 35	11.7		15.3		6.4		11.7	
35 X 48	8.0		9.7		0.7		6.1	
48 X 65	12.0	12.6	11.6	16.7	9.1	15.3	11.8	11.3
65 X 80		0.6		0.7		Tr		0.7
80 X 100	4.1		3.4		1.8		3.3	
100 X 200	0.4		0.6		0.2		0.5	
-200	Tr	Tr	Tr	0.2	Tr	Tr	Tr	0.3
% Char	38.3		48.6		42.3		35.1	
% Ash + SO_3	12.64		12.96		11.92		10.84	
Ash Elemental Analysis, Wt %								
SiO_2	16.28							
SO_3	3.12							
Na_2O	1.26							

Table 28-14. PURGED FUEL CHAR MATERIAL, RUN 28B (Sheet 6 of 6)

Date	8/30/75	8/31/75	9/1/75
Time	1600	1830	1600
Ultimate Analysis, Wt %			
H_2O	0.60	3.12	
C	60.73	42.64	56.28
H	1.05	1.01	2.66
S	0.89	0.53	0.37
Ash + SO_3	29.49	25.54	18.76
Elemental Analysis, Wt %			
SiO_2	25.99	27.21	22.87
SO_3	9.61	7.09	7.48

Table 28-15. GASIFIER CHAR TO ORGANIC POND, RUN 28A

Date	9/16/75	9/17/75	9/28/75	9/19/75	9/20/75	9/21/75	9/22/75	9/23/75	9/24/75	9/25/75	9/26/75	9/27/75
Screen Size, Wt % Tyler Mesh												
+60	6.9	12.1	2.7	2.7	2.2	2.8	1.6	1.8	0.7	0.9	1.0	0.8
60 X 100	19.1	19.2	9.5	12.5	11.1	10.1	12.1	10.4	10.8	10.1	14.2	13.8
100 X 325	69.4	32.9	41.6	42.4	43.1	40.2	39.6	39.0	41.7	48.0	40.4	44.8
-325	4.6	35.8	46.2	42.3	43.6	46.9	46.7	48.8	46.8	41.1	44.4	40.5
Ultimate Analysis, Wt %												
C	60.23	58.57	60.19	61.84	60.95	61.02	60.44	62.32	53.17	62.49	62.20	64.60
H	2.18	1.82	1.38	2.76	1.63	1.96	1.72	1.85	0.88	1.88	1.99	1.55
S	0.88	0.81	0.55	0.63	0.49	0.57	0.82	0.94	0.69	0.47	0.45	0.57
Ash + SO_3	30.28	28.46	19.94	18.64	23.43	21.28	23.04	21.38	24.86	19.41	21.84	21.33
Elemental Analysis, Wt %												
SiO_2	18.20	18.49	20.18	24.20	20.07	15.58	13.09	14.41	20.20	17.13	14.81	15.25
SO_3	7.20	7.03	6.85	8.40	5.21	6.68	8.00	7.90	6.95	6.74	5.14	6.65
Na_2O	1.03	1.36	1.52	1.38	1.03	1.02	1.09	1.19	0.97	0.85	1.16	1.03
CaO	42.32	49.58	47.65	39.55	47.44	53.29	55.60	54.37	46.78	51.83	53.34	53.04
MgO	4.12	4.71	4.54	3.92	4.21	4.08	4.42	4.63	4.34	4.61	4.14	4.26
K_2O	0.14	0.22	0.16	0.31	0.20	0.18	0.23	0.24	0.19	0.18	0.25	0.19
P_2O_5	0.06	0.06	0.02	0.35	0.13	0.29	0.28	0.37	0.29	0.36	0.34	0.07
Al_2O_3	12.99	11.58	11.73	12.97	11.43	10.90	9.96	10.29	10.34	10.50	11.37	11.08
Fe_2O_3	13.08	5.54	5.89	8.64	6.40	5.86	5.53	5.58	8.41	6.18	6.43	6.68
TiO_2	0.62	0.59	0.41	0.52	0.54	0.49	0.50	0.52	0.52	0.49	0.53	0.49

Table 28-16. GASIFIER CHAR TO ORGANIC POND COMPOSITES, RUN 28B

Date	8/29/75	← 8/30/75 →			8/31/75		9/1/75	
Time	2030	1120	2000	0800	1120	1900	0545	1000
Screen Size, Wt %								
Tyler Mesh								
+35	0.5	0.4	0.9	0.8	1.3	1.4	2.2	1.8
35 X 48	0.7	2.3	6.2	4.1	5.2	5.9	5.8	5.7
48 X 65	3.9	6.4	13.2	9.3	10.5	5.2	10.1	11.7
65 X 100	8.9	8.7	18.2	13.9	13.8	15.8	14.5	16.2
100 X 200	21.4	12.3	23.2	21.8	22.1	24.0	24.0	25.7
200 X 325	15.1	7.8	9.4	15.2	13.0	12.2	12.2	12.4
-325	49.5	62.1	28.8	35.0	34.0	35.4	31.0	26.4
% Calcine Weight Change				-11.57			-4.3	
Elemental Analysis Wt %								
SiO_2				31.54			24.89	
SO_3				3.00			3.53	

Table 28-17. ASH AND ATTRITED ACCEPTOR, RUN 28A

Date	9/15/75	9/17/75	9/18/75	9/19/75	9/20/75	9/21/75	9/22/75	9/23/75	9/24/75	9/25/75	9/26/75
Screen Size, Wt % Tyler Mesh											
+35	3.6	1.2	1.9	3.9	2.5	1.1	2.1	4.7	1.9	1.7	4.2
34 X 48	4.4	4.4	4.1	5.7	4.0	3.2	3.3	4.7	4.6	2.6	4.3
48 X 65	10.6	9.0	8.3	11.5	10.6	7.3	7.0	8.4	9.8	6.5	8.5
65 X 100	15.8	14.0	13.1	15.9	15.5	13.4	12.3	13 0	16.1	12.7	13.3
100 X 200	21.8	24.5	25.0	24.1	26.1	25.3	23.8	22.1	24.7	25.0	22.7
200 X 325	10.2	13.9	18.3	16.1	18.9	14.9	15.1	13.2	12.6	15.2	20.8
-325	33.6	33.0	29.3	22.8	22.4	34.8	36.4	33.9	30.4	36.2	26.1
% Calcine Weight Change		-3.7	-4.1	-5.0	-6.6	-2.9	-6.2	-7.0	-13.2	-3.7	-5.8
Elemental Analysis, Wt %											
S=		1.05	0.56	1.10	1.42	2.15	1.39	1.25	2.21	1.13	1.00
SiO_2		9.87	14.69	15.51	20.38	18.50	17.28	16.45	18.96	17.33	18.38
SO_3		2.36	2.35	5.48	7.67	7.34	5.51	4.66	7.84	5.89	5.88
Na_2O		0.19	1.00	0.92	1.26	0.89	1.44	1.27	1.08	1.02	1.03
CaO		57.63	67.56	63.66	57.03	57.57	59.16	63.05	58.84	61.82	60.50
MgO		11.14	4.68	4.64	4.26	4.37	4.70	4.73	4.04	4.69	4.53
K_2O		0.06	0.33	0.31	0.38	0.38	0.43	0.37	0.35	0.31	0.34
P_2O_5		0.07	0.08	0.07	0.07	0.08	0.06	0.07	0.08	0.08	0.11
Al_2O_3		13.06	6.84	6.64	6.84	8.23	8.63	7.11	6.28	6.14	6.70
Fe_2O_3		5.18	2.32	2.68	2.35	2.51	2.52	2.20	2.46	2.56	2.35
TiO_2		0.50	0.19	0.21	0.22	0.24	0.42	0.20	0.23	0.27	0.27

Table 28-18. ASH AND ATTRITED ACCEPTOR COMPOSITES, RUN 28B

		Balance Period No. 1	Balance Period No. 2
Date		9/22/75 - 9/24/75	9/25/75 - 9/27/75
Time		1600 Hrs - 0100 Hrs	1600 Hrs - 0800 Hrs
		Temperature, °F	
Gasifier			
Lignite Feed	TE-2215/2216	315	315
Boot Heater Outlet	TE-2058	1400	1400
Boot Inlet Gas	TE-2040	1330	1330
Side Flow Heater Outlet	TE-2057	1550	1550
Regenerator			
Air Heater Outlet	TE-2047	800	800
Air Inlet to Regenerator	TE-2026	830	830
Acceptor Lift Gas Heater Outlet	TE-2050	(Out of Service, TE-2013 Used)	
Lift Gas Temperature at Engager Pot	TE-2013	1400	1400
Char Lift Gas Heater Outlet	TE-2054	800	800
Char Lift Station Gas Temperature	TE-2041	765	760
Char Disengager Pot Temperature	TE-2028	545	520

Table 28-19. BALANCE PERIOD AVERAGE PREHEATS, RUN 28B

Date			9/15	← 9/16 →		← 9/17 →		← 9/18 →		9/19
Time			2315	1100	1500	2140	0250	0700	0650	2300	1400
DPR-*	Chart	Zero	Range In. W.C.	Chart Readings							
2030	-10/10	9.0	554.0	5	5	4.6	6.1	6	6	3	2.5	1.5
2089	0/100	4.2	25	19	18	18	19	24	29	62	19	15
2088	0/100	3.0	168.7	22.5	20	21	22	25	28	33	32.5	34
2087	0/100	3.0	43.7	69	58.5	58	57	59	61	68.5	71	71
2094	0/100	3.0	53.9	80	62	63	61	63	65	73	77	76
2093	0/100	3.0	115.4	41	32	31.5	30.5	31.5	32	36.5	37.5	38
2001	0/100	3.0	126.2	23	17.5	18	18	19	19	21	22	22
2002	0/100	3.0	57.1	41	41	41	41	41	41	41	40	40
2083	0/100	3.0	57.7	69	69	67	65	63	63	62	62	56
2019	0/100	4.2	300.0	30	49	42	35	35	27	32	38	39
2037	-10/10	9.0	40.0	-2	-2	-2	-2	-2	-2	-2	-2	-2
2021	0/100	4.2	50.0	70	82	84	80	83	80	75	70	62
2022	0/100	4.8	25.0	54	64	65	59	60	59	52	47	43
2073	0/100	3.0	150.0	47	46	45	43	42	42	38	37	33
2074	0/100	3.0	180.0	78	70	67	68	68	65	68	65	60
2075	0/100	3.0	180.0	71.5	73	74	71	70	68	65	64	58
2076	0/100	3.0	144.0	53	52.5	52	48	47.5	46	42	44	38
2077	0/100	3.0	144.0	12	25	27	25	27	23	22	24	24
2024	0/100	4.2	98.6	47	49	45	52	49	49	28	24	15
2025	0/100	4.2	300.0	43	44	42	48	46	45	25	24	15
2026	-10/10	9.0	40.0	0	0	-2.4	-2.1	-2	-2.2	-2.2	-1.4	-1.2
2102	0/100	4.2	100.0	35	35	23	30	31	30	31	31	40
2020	0/100	4.2	300.0	63	64	67	55	57	50	70	75	70
2036	-10/10	9.0	20.0	-2	-2.4	-2	-2	-3	-3.5	-3	-2	-3
2028	0/100	4.8	50.0	39	54	55	56	59	60	63	65	54
2080	-2/2	9.0	40.0	63	69	67	70	70	71	70	70	69
Location*				Pressure, In. W.C.**								
1				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2				43.9	38.3	41.4	42.5	48.8	56.3	74.5	60.9	63.6
3				165.6	131.2	137.1	133.4	142.4	150.9	186.1	175.3	174.9
4				258.4	213.5	221.5	214.8	223.5	230.9	271.7	260.4	254.4
5				320.0	327.0	318.1	288.8	297.2	280.7	338.7	344.1	338.7
6				316.0	323.2	314.1	284.9	293.4	276.9	334.8	340.2	334.9
7				264.2	260.3	252.0	225.1	231.4	216.0	280.6	289.0	287.6
8				192.4	187.1	182.5	157.1	164.8	148.4	221.8	231.0	234.4
9				-143.1	-144.7	-134.2	-157.2	-148.0	-147.3	-65.2	-58.6	-22.9
10				-161.0	-181.6	-172.6	-193.7	-187.4	-180.4	-96.5	-93.4	-57.2
11				0.0	0.0	5.0	4.3	4.1	4.6	4.6	2.9	2.5
12				75.9	71.7	61.5	70.4	77.9	84.8	102.7	89.6	102.4
13				230.7	236.2	230.1	205.7	219.9	206.6	279.8	284.5	286.6
14				220.7	223.7	220.0	195.3	204.3	188.2	264.7	274.3	270.9
15				197.3	194.1	188.9	164.5	172.2	156.1	229.5	238.5	241.3

*Refer to figure.
**Static pressure at location 1 is 150 PSIG. Pressures listed are differential pressures from location 1.

Table 28-20. PRESSURE BALANCE DATA, RUN 28B (Sheet 1 of 3)

Date				← 9/20 →				← 9/21 →			← 9/22 →		
Time				0440	0720	1455	2000	0615	1515	2300	0830	1315	2230
DPR-*	Chart	Zero	Range In. W.C.	Chart Readings									
2030	-10/10	9.0	554.0	3.2	3	1.3	2	1.2	1.5	1.5	1.5	1.5	1.8
2089	0/100	4.2	25	27	28	18	18	14	52	36	46	35	15
2088	0/100	3.0	168.7	30	30.5	34	34	28	33	32	33	33	32
2087	0/100	3.0	43.7	60	62	70	68.5	68	63	65	66	67	66
2094	0/100	3.0	53.9	64	67	75	75	73	68	70	71	73	71
2093	0/100	3.0	115.4	32	34	37.5	38	37	34.5	35.5	36	36.5	35
2001	0/100	3.0	126.2	18.5	20	22	22	21	19.5	20	21	22	11
2002	0/100	3.0	57.1	40	35.5	36	35	36	36	35.5	36	35	36
2083	0/100	3.0	57.7	53	51	50	50	51	49	49	49	48	50
2019	0/100	4.2	300.0	25	27	33	29	39	33	28	25	36	34
2037	-10/10	9.0	.40.0	-2	-2	-2	-2.4	-1.2	-1.8	-2.0	-2.0	-0.8	-2.4
2021	0/100	4.2	50.0	70	70	68	69	64	77	72	78	75	81
2022	0/100	4.8	25.0	51	53	50	48	50	58	55	56	58	57
2073	0/100	3.0	150.0	31	31	31	30	30	29	29	29	29	30
2074	0/100	3.0	180.0	55	57	55	54	65	53	54	53	54	55
2075	0/100	3.0	180.0	55	53	53	52	53	52	52	49	53	54
2076	0/100	3.0	144.0	36	35	34	33.5	35	33	33	31	33	34
2077	0/100	3.0	144.0	16	12	16	11	19	17	16	8	19	18
2024	0/100	4.2	98.6	30	28	14	18	14	17	17	18	15	16
2025	0/100	4.2	300.0	26	22	15	17	13	17	17	17	15	19
2026	-10/10	9.0	40.0	-1.2	-1.2	-1.2	-1.2	-1.2	-1.4	-1.4	-1.4	-1.3	-1.3
2102	0/100	4.2	100.0	38	39	39	41	53	46	46	45	46	45
2020	0/100	4.2	300.0	50	53	68	60	65	58	58	54	66	62
2036	-10/10	9.0	20.0	-2.5	-2.5	-2.4	-3.6	-2.5	-2.5	-2.5	-2.5	-2.4	-2.6
2028	0/100	4.8	50.0	49	52	62	55	54	55	63	64	72	63
2080	-2/2	9.0	40.0	63	65	67	67	67	67	69	69	72	67
Location*				Pressure, In. W.C.**									
1				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2				59.5	61.2	62.9	63.9	55.1	69.2	66.0	69.8	64.6	60.4
3				155.2	161.6	176.3	174.5	164.0	171.9	172.5	176.8	172.9	169.3
4				230.2	234.8	252.8	248.6	238.4	244.2	245.6	250.9	246.5	233.4
5				275.3	285.7	322.2	304.7	323.9	313.2	300.3	296.3	323.5	307.2
6				271.5	281.9	318.3	300.1	321.6	309.7	296.4	292.4	322.0	302.4
7				219.0	228.9	267.7	248.3	272.1	252.1	242.5	234.8	264.9	244.6
8				169.8	179.6	219.1	200.2	224.2	206.4	197.1	188.9	218.7	198.5
9				-71.9	-58.0	-21.5	-31.9	-16.4	-29.8	-31.0	-31.7	-21.9	-36.4
10				-95.2	-75.6	-45.3	-48.4	-42.4	-55.3	-54.0	-44.0	-50.4	-62.3
11				2.5	2.5	2.5	2.5	2.6	2.8	3.0	2.9	2.6	2.7
12				95.5	98.3	99.5	103.5	106.9	113.2	109.7	112.9	109.1	102.2
13				214.9	227.0	272.1	255.3	273.3	256.2	251.8	243.9	278.1	253.6
14				202.1	214.2	259.4	236.6	260.4	243.5	239.1	231.1	265.7	240.6
15				174.5	185.1	225.5	206.4	230.5	212.7	204.2	196.0	226.9	205.0

*Refer to figure.
**Static pressure at location 1 is 150 PSIG. Pressures listed are differential pressures from location 1.

Table 28-20. PRESSURE BALANCE DATA, RUN 28B (Sheet 2 of 3)

Date				← 9/23 →			← 9/25 →			← 9/26 →			9/27
Time				0810	1515	2300	0850	1500	2330	0700	1330	2310	0640
DPR-*	Chart	Zero	Range In. W.C.	Chart Readings									
2030	-10/10	9.0	554.0	1.5	2	2	1.7	2.5	2.4	3	2.5	2.5	2.4
2089	0/100	4.2	25	44	38	25	43	32	27	30	32	23	30
2088	0/100	3.0	168.7	31	31.5	30.5	31	31	31	32	31	31	30
2087	0/100	3.0	43.7	62	63	60.5	59	60.5	62.5	62	60.5	59.5	58.5
2094	0/100	3.0	53.9	67	68	66	64	65	68	69	65	64	62
2093	0/100	3.0	115.4	34	34	33	33.5	33	34	33	33	32.5	32
2001	0/100	3.0	126.2	19	19	18	18	18	19	18	18	18	17
2002	0/100	3.0	57.1	35	33	32	34	34	33.5	33	34	34	34
2083	0/100	3.0	57.7	49	48	48	50	50	49.5	50	50	49	49
2019	0/100	4.2	300.0	40	35	39	39	40	35	37	40	39	37
2037	-10/10	9.0	40.0	-2.2	-2.2	-2	-3.7	-2.5	-3	-3.0	-2.5	-2.5	-1.5
2021	0/100	4.2	50.0	77	81	79	74	79	80	75	79	75	75
2022	0/100	4.8	25.0	59	60	59	51	60	51	55	60	58	58
2073	0/100	3.0	150.0	30	30	30	31	31.5	31	30	31.5	31	31
2074	0/100	3.0	180.0	54	54	56	50	50	50	53	50	50	48
2075	0/100	3.0	180.0	53	54	54	54	57	55	55	57	54	53
2076	0/100	3.0	144.0	35	34	34	35	36.5	35	34	36.5	35	36
2077	0/100	3.0	144.0	19	18	17	17	23	17	18	23	18	19
2024	0/100	4.2	98.6	17	22	22	18	25	30	24	25	25	24
2025	0/100	4.2	300.0	16	19	18	16	23	20	21	23	20	21
2026	-10/10	9.0	40.0	-1.3	-1.5	-1.5	-1.2	-1.4	-1.2	-1.3	-1.4	-1.4	-1.2
2102	0/100	4.2	100.0	46	34	34	47	40.5	40	43	40.5	40	41
2020	0/100	4.2	300.0	64	63	65	61	66	64	60	66	65	60
2036	-10/10	9.0	20.0	-2.4	-2.4	-3.2	-3.2	-1.5	-5	0	-1.5	-1.6	-1.6
2028	0/100	4.8	50.0	61	63	60	53	59	62	59	59	57	54
2080	-2/2	9.0	40.00	70	71	70	69	71	72	72	71	70	70
Location*				Pressure, In. W.C.**									
1				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2				63.7	63.9	59.8	63.8	60.1	58.6	59.5	56.7	55.5	56.2
3				164.8	166.1	158.0	161.6	161.2	159.8	161.8	157.3	154.4	152.1
4				235.9	235.6	225.2	231.5	228.5	229.8	232.0	228.9	225.2	221.1
5				325.3	310.5	311.2	318.1	300.5	304.1	313.7	320.4	313.7	302.8
6				321.0	306.2	307.3	310.8	294.5	298.3	307.7	315.4	308.7	299.8
7				263.2	246.2	248.1	256.6	235.1	240.6	252.6	257.6	253.3	244.0
8				215.8	198.9	200.4	207.8	184.5	191.4	205.9	209.1	205.5	195.7
9				-26.9	-40.9	-38.4	-28.2	-54.4	-50.9	-46.8	-51.9	-44.1	-47.0
10				-55.3	-67.4	-63.2	-53.6	-78.7	-76.7	-74.8	-88.2	-72.4	-76.5
11				2.6	3.1	3.1	2.4	2.4	2.4	2.5	2.7	2.7	2.3
12				107.8	95.6	91.8	108.9	106.8	96.8	99.9	94.3	92.5	94.6
13				269.3	253.8	257.3	261.0	251.8	259.3	247.4	258.1	253.6	242.0
14				257.0	241.5	240.9	244.7	222.7	233.6	247.4	250.7	245.6	233.9
15				223.3	206.8	207.9	214.9	192.1	199.7	214.2	217.2	213.2	203.3

*Refer to figure.

**Static pressure at location 1 is 150 PSIG. Pressures listed are differential pressures from location 1.

Table 28-20. PRESSURE BALANCE DATA, RUN 28B (Sheet 3 of 3)

RUN 29

RUN 29A OCTOBER 16 TO OCTOBER 25, 1975

RUN 29B NOVEMBER 7 TO NOVEMBER 17, 1975

CO_2 ACCEPTOR PROCESS GASIFICATION

PILOT PLANT

RAPID CITY, SOUTH DAKOTA

1 SUMMARY

Runs 29A and 29B were completed during the respective periods of October 16 to 25, 1975 and November 7 to 17, 1975. These runs featured the use of Velva lignite as feedstock and Minnekahta limestone as acceptor. Run 29A ended prematurely due to the failure of the new acceptor lift gas heater. When the heater failed, air was still being used to supply heat to the gasifier since fresh acceptor makeup to the system had only been initiated four hours earlier. The heater failure was due to sulfur attack of the tube metal near the outlet tube ends.

Run 29B was more successful than Run 29A. Acceptor change-out of the initial dead-burned dolomite inventory was sufficient to allow the total removal of air as a gasifier heat source for 52 hours. In addition, steam rather than recycle gas was used to fluidize the gasifier boot acceptor for more than 35 hours.

During Run 29B the methanation unit was put on stream for the first time. Purified synthesis gases were successfully processed in the unit to produce a high heat content product stream for more than 49 hours.

2 TEST DATA

Runs 29A and 29B are presented graphically and/or tabularly at the end of this run report. These figures and tables include:

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3 SIGNIFICANT EVENTS AND OBSERVATIONS

3.1 RUN HISTORY

3.1.1 Objectives

The goals for Runs 29A and 29B were:

(1) To check out and operate the methanation unit using synthesis gas.

(2) To operate the pilot plant under steady-state conditions for a 7-day period without the need to supply air as a source of heat to the gasifier.

3.1.2 Accomplishments

Run 29A

The normal startup sequence was successfully completed past the step of feeding fresh acceptor makeup to the system.

Run 29B

(1) Confirmed again that pure steam could be used to fluidize the collected acceptor in the gasifier boot.

(2) Demonstrated that the packed tube methanation reactor, DC-402, could be successfully operated to produce a high BTU content gas.

3.1.3 Termination Causes

Run 29A

The run ended due to the rupture of the acceptor lift gas heater coil. Sulfur attack caused the failure.

Run 29B

The run was terminated after the line which leads to the spent acceptor dump hopper, F-213, plugged and could not be cleared.

3.1.4 Mechanical Problems

Run 29A

(1) Early in the startup a hot spot developed on the shell of the regenerator fuel char lift pot. The pilot plant

was shut down to allow inspection and repairs. The end plates on the gas line from the lift pot and the exit nozzle of the lift pot were broken. These were repaired. Gas bypassing through the broken end plates had caused the shell hot spots.

(2) An apparent restriction developed in the regenerator fuel char lift pot. This required another system shut down to clear. The subsequent inspection did not reveal any plug. Depressuring the system may have caused the plug to disintegrate.

(3) Lignite feed was lost once due to a plugged sensing tap on a lignite lockhopper, F-204. This caused a system pressure swing which resulted in the loss of stable fuel char transfer for about 5-1/2 hours.

(4) The pressure shell expansion joint bellows, EJ-2, of the recarbonated acceptor standleg, CD-204, developed a leak. This required yet another system shutdown and depressuring to repair.

(5) The new coil in the acceptor lift gas heater, B-205, ruptured due to corrosive sulfur attack.

(6) Instability in the gasifier char-acceptor interface control occurred twice during the run. The cause of the instability was not definitely determined. One possible explanation is that the small fluidized bed of acceptor in the engager pot, F-222, may have periodically covered the recarbonated acceptor inlet to the engager pot, thus, blocking the flow of acceptor from the standleg, CD-204. To correct this problem, the fluidized acceptor bed level was lowered by extending the acceptor lift line dip tube 5 inches further into the engager pot.

Run 29B

(1) A leak developed between the inner process containing pipe and the surrounding water jacket of the gasifier overhead line, GP2-201. Process gas was leaking into the jacket water system. The leak was discovered after the regenerator and gasifier reactors were at operating conditions and lignite feed to the gasifier had commenced. To perform the minor required repairs, the entire system had to be shut down and the vessel contents drained. The leak was located at an elbow weld.

(2) The fuel char transfer from the gasifier to the regenerator was upset several times due to a faulty vent valve switch. The switch allowed the automatic programmer, which actuates the valve sequencing for the filling and dumping of the char removal lockhoppers, to return the F-215 lockhopper to service in an overpressured condition. The problem was easily corrected by repairing the switch.

(3) The shaft key for the spent acceptor flow control valve, XCV-2073, fell out of position on the last day of the run. When this was discovered and the key replaced, the dump line between the gasifier boot and the dump hopper, F-213, was found to have plugged. Loss of the valve operation had apparently allowed the acceptor material above the valve to cool and plug the line. Since the line could not be cleared, the pilot plant had to be shut down.

3.2 CHRONOLOGY OF OPERATIONS

3.2.1 Run 29A

Date	Time	Hours Run	Description
10/15	1800	-202.5	Started grinding lignite in the 100 area to check out the new slurry system for transporting baghouse char and coal fines to the settling pond.
"	2115		Shut down grinding due to problems with the fines slurry system and B-102, preheater furnace.
10/16	0730		Resumed grinding lignite to the preheater.
"	2330	-173.0	Started pressuring up the system with J-309, char lift gas compressor, and air.
10/17	0130		System up to pressure. Started all recycle gas compressors. Shut down J-201B, gasifier recycle gas compressor, for maintenance.
"	0210		Lit all heaters except for B-205.
"	0230		Started steam flow through B-205 heater for coil oxidation. Lit heater and holding it at 250°F.
"	0345		Gasifier temperature at 250°F, started holding period.
"	0400		B-203, regeneration air heater, B-204, recycle flue gas heater, and B-205 heaters are at 250°F, started raising heater temperatures at 100°F per hour.

Date	Time	Hours Run	Description
10/17	0710		Finished grinding lignite, preheater full, and shut down the 100 area.
"	0730		Tested gas flow through Elliott turbine blade test stand. OK.
"	0820		B-207, steam superheater, lit off. Pressure indicators show that char transfer pot, F-224, is plugged.
"	0845		J-201B compressor placed on line.
"	1000		"A" and "B" gas dryers placed on air to dry out. Started the heater differential pressure tests.
"	1155		Finished the heater differential pressure tests.
"	1200		Finished the temperature hold period on the gasifier and began raising temperatures at 50°F per hour.
"	1245		B-204 at 1400°F, started temperature holding period. Checked gas flow to the methanation unit. OK.
"	1645		Started air to B-205 and slowly removed steam.
"	1710		All steam flow out of B-205.
"	2100	-151.5	Attained 700°F in the gasifier and began a temperature holding period.
10/18	0100		"A" and "B" gas dryers placed on line.
"	0225		Cut the temperature in B-204 heater and removed air from the system.
"	0830		Started plant shutdown to allow inspection of hot spot on fuel char lift station.
"	0953		Plant depressured. NOTE: Plug found in char lift pot. Broken end plates were found and work on the inlet flange of the char transfer line CO-204 and on the exit nozzle of the char lift pot.
"	1800		Started pressuring up the system with air.
"	1910		System pressure up to 100 PSIG.
"	1925		Started all recycle gas compressors.
"	1938		Lit all heaters.
"	2020		Started gas flow tests.
"	2115		"A" and "B" gas dryers placed on line.
"	2150		B-205 shut down due to a bad temperature shutdown thermocouple.
"	2300	-125.5	Finished the gas flow tests. Jumpered the bad thermocouple on B-205 and resumed bringing the temperature up on the heater.

Date	Time	Hours Run	Description
10/19	0430		B-205 at 1400°F and holding.
"	0600		Gasifier temperature at 700°F.
"	0900		Shut down J-201A due to a plugged suction bottle.
"	1100		Finished the curing procedure for a B-205 heater and started cooling it down.
"	2245	-101.75	Stopped gas circulation, shut down the heaters and began cooling the system.
10/20	0600		System depressured for maintenance. NOTE: Oxidation of the B-205 heater coil was completed. The flow orifices, FR-2013, and FR-2014, were swapped prior to the run to allow obtaining the required gas flows for the heater coil oxidation. The system was depressured to allow reinstallation of the orifices in the proper locations.
"	1105		Started pressuring up the system with air.
"	1240		System up to pressure, started the static pressure test.
"	1350		Finished the static pressure test.
"	2025		Started all recycle gas compressors.
"	2100	-79.5	Lit all heaters.
10/21	0350		Started depressuring the system to remove apparent plug in the char lift line, CO-204.
"	0600		System depressured. NOTE: A plug was not found in CO-204. However, a broken differential pressure tap on line CO-204 (high side of dPT-2029) was repaired.
"	1110		Started pressuring up the system with air.
"	1300		System up to pressure.
"	1345		Started all recycle gas compressors.
"	1400		Lit all heaters.
"	1419		"A" and "B" gas dryers placed on line.
"	1500		"A" and "B" gas dryers off line to dry out.
"	1625		Started depressuring the system due to a leak at EJ-2, expansion joint in line CD-204.
"	1830	-58.0	System depressured. NOTE: EJ-2 was replaced with a new expansion joint.
10/22	0730		Pressuring up the unit with air.
"	1045		System up to pressure, started all recycle gas compressors.
"	1050		Lit all heaters.

Date	Time	Hours Run	Description
10/22	1105		"A" and "B" gas dryers placed on line.
"	1930	-33.0	Started heater differential pressure test.
10/23	0030		Completed the heater differential pressure test.
"	0040		Started feeding dead-burned dolomite to the gasifier via F-204A, fresh lignite feed lockhopper.
"	0225		Transferred first batch of dead-burned dolomite to the regenerator.
"	0235		Started filling the regenerator with dead-burned dolomite via F-206, fresh dolomite lockhopper.
"	0925		Transferred a batch of dead-burned dolomite from the regenerator to the gasifier. Started solids circulation.
"	1100		Started solids circulation tests.
"	1240		Finished the solids circulation tests. Stopped solids circulation.
"	1250		Started lift line gas flow tests.
"	1407		Finished lift line gas flow tests.
"	1426		Introduced steam to the gasifier side flow and started removing recycle gas.
"	1449		Started char addition to the gasifier via F-204A.
"	1615		Started withdrawing dead-burned dolomite to F-213, purged dolomite lockhopper.
"	1730		Started auxiliary fuel feed to the regenerator.
"	1900		Started air flow to the gasifier side.
"	1915		Lost auxiliary fuel feed for 5 minutes.
"	2125	-70.8	Introduced steam into the gasifier boot flow.
10/24	0010		Started grinding lignite in the 100 area.
"	0110		Established char transfer to the regenerator.
"	0240		Finished grinding lignite and began grinding char to tote bins.
"	0430	0	Regenerator at 1800^{o}F.
"	1015		Stopped grinding char and started grinding lignite.
"	1023		Started feeding lignite to the gasifier via F-204A.
"	1205		Started synthesis gas to the methanation unit.
"	1540		Sheared a pin on L-204A, fresh dolomite feeder.
"	1555		L-204A back on line.

Date	Time	Hours Run	Description
10/24	1630		High pressure in F-204A stopped lignite feed to the gasifier. Loss of feed caused pressure swing between the system vessels and char transfer and auxiliary char feed were lost.
"	1700		Stopped grinding lignite due to a high dryer furnace temperature and a high differential pressure across the baghouse.
"	1915		Resumed grinding lignite.
"	1950		Stopped feeding lignite to the gasifier. NOTE: The vent on F-204A was plugged and had to be cleaned out.
"	2030		Started feeding char to the gasifier via F-204B.
"	2140		Finished grinding lignite and shut down the 100 area
"	2200		Reestablished char transfer to the regenerator.
"	2220		System lined out and lignite feed to the gasifier resumed.
10/25	0223		Experienced an upset in the gasifier boot. Stopped dolomite circulation.
"	0230		Gasifier boot back under control. Resumed dolomite circulation.
"	0300	22.5	Started fresh limestone makeup to the regenerator.
"	0350		Started grinding lignite for the preheater.
"	0500		Char transfer lost.
"	0600		Experienced another upset in the gasifier boot. Increased the boot flow and lowered the differential pressure between the system vessels. Char transfer was regained along with boot stability.
"	0710		Gasifier boot upset and lift line dP's indicate a plugged lift line.
"	0740	27.2	Ruptured tube in B-205 heater discovered and activated an ESD-2 shutdown. By reducing the lift gas flow to the engager pot, F-222, the ruptured heater caused the lift line to plug.
"	0825		System depressured.
"	0920		Shut down the 100 area.

3.2.2 Run 29B

	11/7	0930	-72.5 Started pressuring the system with air.
	"	1100	System up to operating conditions. Started the static pressure test.

Date	Time	Hours Run	Description
11/7	1120		Finished the static pressure test.
"	1225		Started the recycle gas compressors and began gas circulation.
"	1312		All heaters lit.
"	1530		Checked the gas flow through the Elliott turbine blade test stand.
"	1600		System temperature at 250°F and started the first refractory cure temperature hold.
"	1656		Checked the gas flow to the methanation unit.
"	1910		Started the heater differential pressure tests.
"	2125		Finished the heater differential pressure tests.
"	2400		Finished the first refractory cure holding period and began raising system temperature.
11/8	0930	-48.5	System temperature at 700°F. Started the second refractory cure holding period.
"	1130		Maintenance worked on the primary fan, L-109-J1, in the 100 Area to correct excessive vibration and hot bearings.
"	1330		Finished the second refractory cure holding temperature and began raising the system temperature.
"	2123		System up to temperature.
"	2143		Started feeding dead-burned dolomite to the gasifier via F-204A, fresh lignite feed lockhopper.
"	2400		Transferred first batch of dead-burned dolomite to the regenerator from the gasifier.
11/9	0015		Started feeding dead-burned dolomite to the regenerator via F-206, fresh dolomite feed lockhopper.
"	0810		Started circulating dead-burned dolomite.
"	1055		Stopped acceptor circulation to work on TCV-2030.
"	1120		Started lift line gas flow tests.
"	1245		Finished the gas flow tests.
"	1300	-21.0	Resumed acceptor circulation.
"	1430		Stopped acceptor circulation due to erratic TCV-2030 control.
"	1505		Gasification section zinc oxide unit placed on line.
"	1610		Started solids circulation. NOTE: The actuator linkage on TCV-2030 was found to be bent.
"	1615		Started solids circulation tests.

Date	Time	Hours Run	Description
11/9	1710		Finished the solids circulation tests.
"	1715		Started calibration tests for XCV-2073, purged dolomite control valve.
"	1927		Finished the calibration tests for XCV-2073.
"	2015		Started steam to the gasifier side flow.
"	2110		Attempted to feed char to the gasifier via F-204A.
"	2400		NOTE: F-204A will not feed due to a plug just above the feeder. Started feeding char to the gasifier via F-204A.
11/10	0245		NOTE: Wet dead-burned dolomite was found above the feeder. Started air to the gasifier side flow and removed the recycle gas.
"	0530		Started auxiliary fuel char feed to the regenerator. Started char withdrawal.
"	0805		Started steam to the gasifier boot flow.
"	0832		Established char transfer through LCV-2002.
"	1000	0	Regenerator at 1800°F.
"	1145		Char transfer was lost momentarily when F-215, char removal lockhopper, was placed on line.
"	1730		Started feeding lignite to the gasifier via F-204A.
"	1935	9.6	Shutting down the system.
11/11	1500		NOTE: A leak in the gasifier overhead line, GP2-201, water jacket was causing a water hammer. Started pressuring up the system with air.
"	1550		NOTE: The water jacket leak was repaired. System up to operating pressure. Started the static pressure test.
"	1630		Finished the static pressure test.
"	1740		Started all recycle gas compressors.
"	1750		Lit all process gas heaters.
"	1900		Started the heater differential pressure tests.
"	2000		Finished the heater differential pressure tests.
11/12	0415		Started filling the gasifier boot with dead-burned dolomite via F-204A.
"	0650		Transferred a batch of dead-burned dolomite to the regenerator.
"	0700		Started feeding dead-burned dolomite to the regenerator via F-206.

Date	Time	Hours Run	Description
11/12	1355	-17.1	Started circulating dead-burned dolomite.
"	1520		Zinc oxide unit placed on line.
"	1545		Started solids circulation tests.
"	1550		Finished the solids circulation tests.
"	1600		Started steam to the gasifier side flow.
"	1700		Began feeding char to the gasifier via F-204A.
"	1800		Maintenance worked on the primary fan in the 100 area. The fan was balanced and the unit placed on line again.
"	2105		Started air flow to the gasifier side and removed the recycle gas flow.
"	2345		Started steam to the gasifier boot flow.
11/13	0225		Started feeding auxiliary char to the regenerator.
"	0320		Established char transfer.
"	0700	0	Regenerator at 1800°F.
"	0830		Char feed line from F-204A to the gasifier plugged.
"	0910		Char feed resumed.
"	1100		Maintenance finished work on balancing the primary fan in the 100 area.
"	1527	8.45	Began feeding lignite to the gasifier via F-204A.
"	1930	12.5	Began feeding 6 X 9 limestone to the system via F-206.
11/14	0210		Started removing air from the gasifier.
"	1125		Started CO_2 gas flow to the gasifier boot.
"	1515	32.25	Char transfer lost for approximately 10 minutes.
"	1605		Lost char transfer again.
"	1610		Stopped auxiliary char feed.
"	1645		Char transfer regained and auxiliary char feed resumed.
"	1700-1846		Char transfer very touchy and lost several times.
"	1900		Zinc oxide tower "A" removed from service to replace absorbent.
"	2040		The belt on the roller mill, L-109-L1, broke. The 100 area was shut down while maintenance repaired unit.
"	2400		System slowly lining out after earlier upsets.
11/15	0715	48.25	All air out of the gasifier.
"	0955	50.9	The methanation unit was placed on line.

Date	Time	Hours Run	Description
11/15	2328		All recycle removed from the gasifier boot flow.
"	2344		The Redler conveyor, V-109, in the 100 area broke. The unit was shut down while maintenance repaired the conveyor.
11/16	0700	72	Unit lined out except for minor adjustments.
11/17	1045	99.75	Line UAD-206 to F-213 plugged. While attempting to clear the line, an upset occurred in the gasifier boot. Acceptor transfer through LCV-2003 stopped. Overhead transfer was then stopped and the interface was deliberately blown. Steam was removed from the gasifier boot flow and recycle was put in. Lignite feed to the system was stopped.
"	1125		The methanation unit was taken off line and shut down.
"	1540		Initiated shutdown procedures for the system.
11/18	0300		System depressured.

4 RESULTS AND DISCUSSION

4.1 BACKGROUND

The Synthetic Fuels Pilot Plant program, which is sponsored by the Energy Research and Development Administration and the American Gas Association, is committed to demonstrating both the production of synthesis gas from coal and the conversion of the synthesis gas to substitute natural gas (SNG) via methanation. In the program, various methanation schemes are to be demonstrated so that actual operational data can be used in the evaluation of alternate methanation reactor designs. For the CO_2 Acceptor Process Coal Gasification Pilot Plant, a catalyst-in-tube, externally cooled reactor design was assigned for study.

The construction of the gas processing facilities, which incorporated this reactor design, was completed early in 1975. However, due to the premature shutdowns of several runs and the major concentration of effort being directed towards demonstrating the synthesis gas production step, operation of the methanation unit was not attempted until Run 29. For Run 29 the primary objectives were the checkout of the methanation unit equipment and demonstration of the methanation step.

4.2 ACCOMPLISHMENTS

4.2.1 Major Operational Achievements

The pilot plant operational achievements for Runs 29A and 29B are summarized below:

SUMMARY OF PLANT OPERATIONS

HOURS MAINTAINED

	Run 29A	Run 29B
Process Conditions	27	109
Lignite Feed	21	93
Acceptor Circulation	44	149
Fresh Acceptor Makeup	4	87
Without Air to Gasifier	0	52
100% Steam to Boot	0	35
Methanation	0	49

Neither Run 29A nor 29B was of sufficient duration to allow total changeout of the original dead-burned dolomite inventory. Therefore, truly steady-state operation was not achieved. However, a milestone accomplishment was achieved during Run 29B when the methanation unit was started up for the first time and operated. The experience gained during this run was extremely valuable with respect to operator training and the functional checkout of the methanation unit equipment.

4.2.2 Plant Data

Tables 29-1 through 29-11 summarize the plant data for the synthesis gas production facilities. The process flow data are contained in Tables 29-1 through 29-4. Screen analysis and chemical composition data for feedstocks and process solids are presented in Tables 29-5 through 29-11. The methanation unit process flow data are contained in Table 29-12. Table 29-13 contains the data for the temperature profiles that were measured along the axis of selected tubes in the packed tube methanation reactor.

4.2.3 Methanation

Figure 29-1 is a block flow diagram which shows the essential gas processing steps in the methanation unit. The processing steps in order are: (1) shift conversion to allow adjustment of the hydrogen and carbon monoxide content of the quenched synthesis gas; (2) hot potassium carbonate treatment to remove the bulk of the sulfur species in the synthesis gas and most of the carbon dioxide; (3) contact with hydrodesulfurization catalyst to reduce any organic sulfur compounds to hydrogen sulfide; (4) absorption of all trace sulfur on zinc oxide; and (5) methanation of carbon oxides over nickel catalyst.

The shift conversion and the hydrodesulfurizer units were included in the original methanation unit design only because the quality of the synthesis gas from the pilot plant was unknown. At the time the amount and types of sulfur species in the synthesis gas were not known, nor was it known whether the required hydrogen level could be reliably maintained. The use of raw lignite as gasifier feedstock for a fully integrated plant operation was not even attempted until Run 19. Therefore, rather than gamble that a suitable synthesis gas could be directly produced in the gasifier, the decision was made to include hydrodesulfurizer and shift conversion units. Subsequent pilot plant runs have shown that the quenched synthesis gas contained only H_2S and COS as sulfur species. Both species are easily removed in the hot potassium carbonate and the ZnO sulfur guard units. Additionally, during normal pilot plant operation, the raw synthesis gas always has a H_2/CO ratio in excess of 3:1. For Run 29B this was often greater than 4.5:1. Therefore, the hydrodesulfurizer and shift conversion units are not necessary. There are no plans to bring either unit on stream during any future run.

The methanation unit contains two different methanation reactor designs, a packed tube reactor, and an adiabatic reactor. The packed tube reactor design is shown in Figure 29-2. Essentially, the reactor is a floating head exchanger with nickel methanation catalyst filling the tubes. Synthesis gas enters the channel section of the exchanger and travels downward through the tubes. Here reactions between hydrogen and carbon oxides take place to produce methane, water, and heat.

In order to maintain adequate catalyst activity and to minimize carbon deposition on the catalyst, the maximum operating temperature recommended by most catalyst manufacturers is between 850°F and 900°F. Therefore, some means must be provided to control the catalyst temperature rise. In the packed tube methanator, this is accomplished by: (1) diluting the feed gas with recycled product gas; and (2) by transferring a large portion of the reaction heat through the tube walls to a boiling liquid on the outside of the tubes. Dowtherm A is used in the pilot plant as the heat transfer agent.

The packed tube reactor contains 160 1-inch-diameter 14-BWG tubes. Of these, 152 tubes contain 5 feet of 1/8-inch-by-1/8-inch catalyst cylinders. The catalyst is supported at the bottom of the tube by 3 inches of 1/8-inch diameter thermowells which extend axially down the entire length of the tubes. Movable thermocouples are used in the wells to monitor the catalyst temperatures. Figure 29-3 shows the locations of the thermowell-containing tubes, and Figure 29-4 shows two typical temperature profiles obtained during Run 29B.

In order to insure equal gas flow through all tubes, the thermowell-containing tubes were filled with 7 feet of catalyst. Obviously, because the catalyst packing order is different, the temperature profiles will not be exactly identical between tubes which contain and tubes which do not contain thermowells. While possibly not the best means, the present thermowell design was the most practical method of obtaining temperature profiles in the pilot plant reactor. If larger diameter tubes are eventually used, the distinction between the tube temperature profiles should fade.

The operation of the packed tube reactor is of primary concern because the reactor design may be economically attractive for commercial applications. The main advantage of the design is that it would allow minimization or elimination of gas recycle to the methanation reactors.

The adiabatic reactor is an insulated vessel which contains approximately 6.5 cubic feet of catalyst. This reactor was included in the pilot plant design as a cleanup reactor. Its function is only to insure that the concentration of carbon monoxide in the final product gas is below the 0.1 volume percent specification set for SNG from coal.

During Run 29A the methanation unit reactors were held in a standby condition by circulating a hot mixture of nitrogen and hydrogen through the catalyst beds. After lignite feed to the gasifier was established, a slip stream of synthesis gas was admitted to the methanation section's hot potassium carbonate tower. The overhead product from the tower was vented to the plant flare. Carbonate circulation was successfully controlled and maintained between the absorber and the stripper. However, due to an accumulation of pipe scale material (71 weight percent Fe_2O_3) in the block valve which admits synthesis gas to the methanation section, control of the gas flow was unreliable. Before attempts could be made to clear the blocked valve, the acceptor lift gas heater coil ruptured, thus terminating the run.

Except for the discovery of several plugged lines which were easily cleared, operation of the methanation unit during Run 29B was trouble free. As mentioned before, no attempt was made to operate the shift converter or the hydrodesulfurizer reactor. The gas purification consisted of carbon dioxide and bulk sulfur removal in the hot potassium carbonate tower followed by final sulfur removal with zinc oxide.

The packed tube methanator was brought on line slowly by first putting the unit on total recycle and then gradually admitting purified synthesis gas to the reactor. Approximately one-third of the total gasifier product gas was eventually being methanated. The recycle-to-feed-gas ratio had been dropped to 1.6:1 without exceeding the 850°F catalyst temperature limit set for this run.

The gas stream compositions presented in Table 29-12 clearly show that complete conversion of both carbon dioxide and carbon monoxide to methane took place in the packed tube reactor. However, the heating value of the methanated product was low for the run because the potassium carbonate tower was too efficient in removing carbon dioxide from the quench synthesis gas. Adjustment of the tower operation in future runs to leave in enough carbon dioxide to react with the available hydrogen will make possible product gases with heating values of over 900 BTU/SCF.

4.3 PROBLEMS

4.3.1 B-205 Heater Failure

The coil in the acceptor lift gas heater, B-205, was replaced prior to Run 29A. The pipe wall of the previous coil which was fabricated of Incoloy 800 had thinned after 18 months of service. The replacement coil was made of Inconel 702, an aluminum bearing alloy thought to be resistant to carburization attack. To provide a protective resistant oxide film, the coil was carefully pretreated with 1400°-to-

1450°F steam and air. Hot steam was first passed through the furnace coil for 4 hours, then hot air was passed through the coil for 16 hours. Despite this treatment rapid corrosion occurred and the coil failed after only 62 hours of operation. The failure was due to severe sulfur attack of the metal near the high temperature outlet end of the coil.

Since Incoloy 800 material served reasonably well in the acceptor lift gas heater service, a new Incoloy 800 coil was installed in the B-205 heater prior to Run 29B. This action has not solved the corrosion problem. However, the solution is only of academic interest, since commercial plant designs do not incorporate a lift gas heater.

4.3.2 Expansion Joint Failure

During Run 29A the external expansion joint, EJ-2, located on the recarbonated acceptor standleg, CD-204, developed a leak. This was the second time that this expansion joint had failed. The original 304 SS unit failed during Run 19. It was replaced with an identical unit before the new units made of annealed Incoloy 825 alloy were available. Stress corrosion cracking from the inside of the expansion joint was again responsible for the failure of the second expansion joint. The unit was replaced with a new Incoloy 825 alloy unit.

4.3.3 Deposits

After both Runs 29A and 29B, the regenerator and gasifier vessels were opened for inspection. Both regenerator inspections revealed that the reactor was in good condition. Only minor amounts of deposits were found on top and behind the air distributor ring. Although the deposits were not analyzed after Run 29, past analyses have shown that the deposits are mostly dead-burned dolomite. The deposits are not considered to be a process problem, since they formed in a dead, non-fluidized area in the reactor.

The gasifier inspection revealed the following. After Run 29A a large deposit which visually appeared to be dead-burned dolomite was found in the gasifier boot. The deposit filled approximately two-thirds of the boot volume between the boot gas distributor and 18 to 24 inches above the distributor. No deposit was found in the transition section. However, four of the bubble caps on the side flow steam distributor were found to have been burned away. After Run 29B the gasifier boot was found to contain only about 50 pounds of dead-burned dolomite deposit material on the lower walls and on top of the boot distributor. The transition section contained a large funnel-shaped deposit which covered the side flow distributor ring and gradually tapered to the wall about 2 feet above the ring.

The formation of the gasifier deposits is not of particular concern. The deposits were probably not the result of processes which gradually allowed formation, but were rather the result of chaotic conditions which existed in the gasifier after the major upsets which ultimately terminated both runs.

Finally, the destruction of the four side flow distributor bubble caps probably occurred early in Run 29A when the gasifier was being filled with dead-burned dolomite from a lignite lockhopper. Examination of the gasifier temperature charts indicates that a small heel of lignite may have existed in the bottom of the lignite lockhopper or in the piping downstream of the lockhopper. When the dead-burned dolomite was fed, the lignite was also fed and burned in the gasifier. Although the destruction of the bubble caps did not noticeably affect the gasifier operation, actions are being taken to insure that it does not happen again.

5 FUTURE PLANS

Plant operation at the end of Run 29B was essentially identical to the steady-state operation during Run 28B. Two mechanical problems marred the run: (1) the operation of the reject acceptor lockhopper; and (2) operation of the char removal lockhopper. Both of these lockhoppers interact with sensitive areas of the process, the boot and the fuel char standleg. Early in the run, an upset originating in the char removal lockhoppers caused loss of the fuel char flow. Subsequent adjustment of the controls eliminated further upsets. The upset occurring at the reject acceptor lockhopper resulted in loss of control of the char-acceptor interface level and ultimately caused termination of the run. Similar upsets had occurred during Runs 28A and 28B.

The reoccurrence of upsets related to the reject lockhopper led to the conclusion that the hopper had to be moved or modified. The decision was made to move the withdrawal to the top of the regenerator based on the following factors:

(1) The new reject acceptor lockhopper would not interact with a sensitive area of the process.

(2) An existing regenerator nozzle designed to carry acceptor to the devolatilizer could be used for the withdrawal.

(3) Calculations indicated that this system would adequately control the intermediate fines concentration, thereby eliminating the use of the char removal hoppers as well.

Two special runs have been designed to provide important plant data while the new reject acceptor lockhopper is being installed. In these runs, Run 30 and Run 31, the reactors will be operated one at a time. In Run 30 the regenerator will be operated to provide system heat and material balance data in the absence of circulating acceptor. A batch fluidized bed of dead-burned dolomite will be maintained at process temperatures with heat supplied by the combustion of auxiliary fuel with air.

Run 31 will be made using the gasifier alone. The run will consist of two parts. First, Husky char will be fed at rates approaching normal process operation. Heat and material balance data will be obtained. Heat will be supplied by burning a portion of the char bed carbon with air added to the inlet steam. In the second part, Montana subbituminous coal will be fed to the gasifier. A batch of subbituminous coal will be preoxidized. This material will be fed to the gasifier first. Subsequently, unpretreated subbituminous coal will be fed. The run will provide information on the performance of the subbituminous coal with respect to pretreatment level, define any operability problems, and provide some steam-carbon kinetics data.

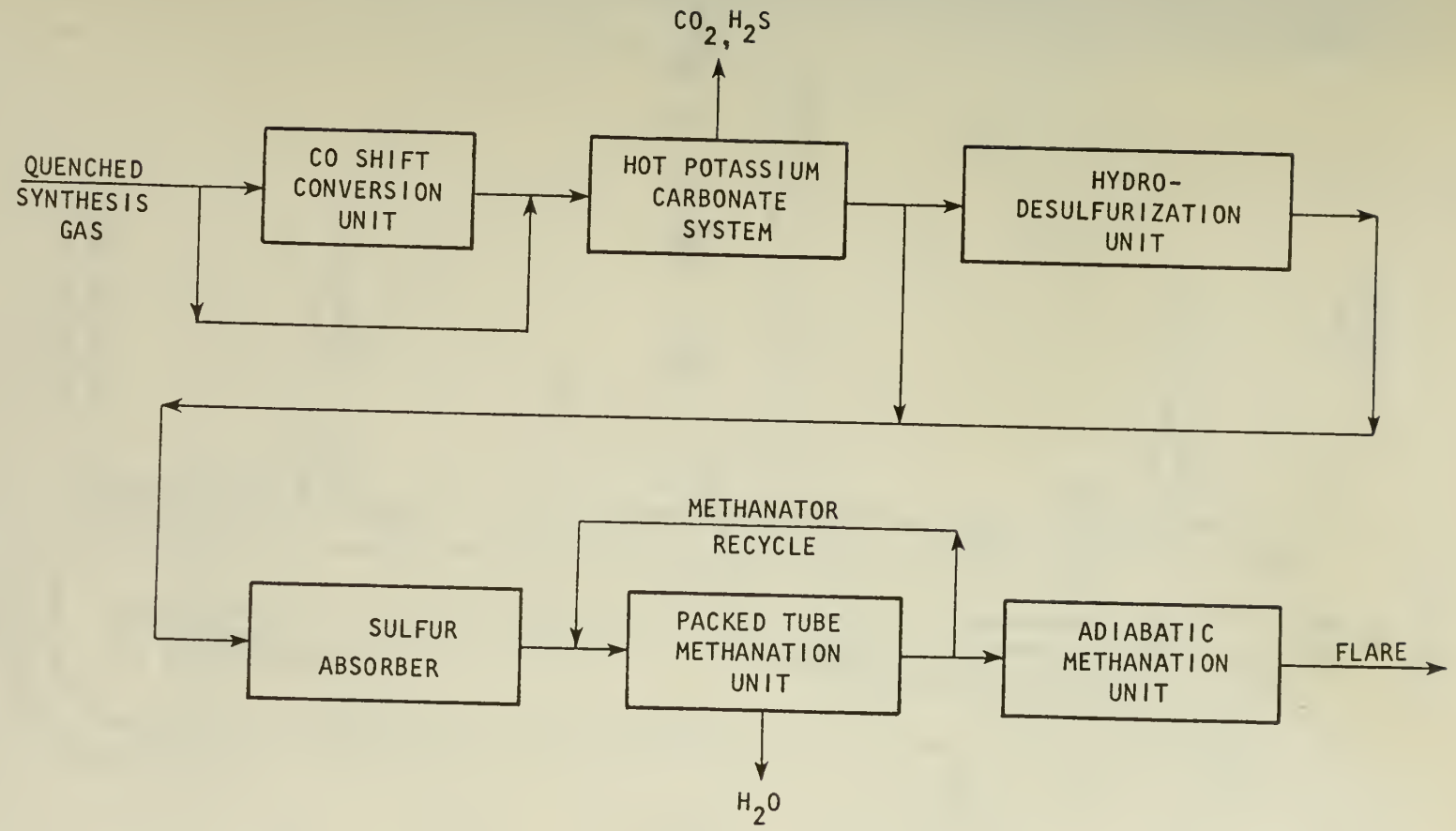

Figure 29-1. METHANATION UNIT BLOCK FLOW DIAGRAM

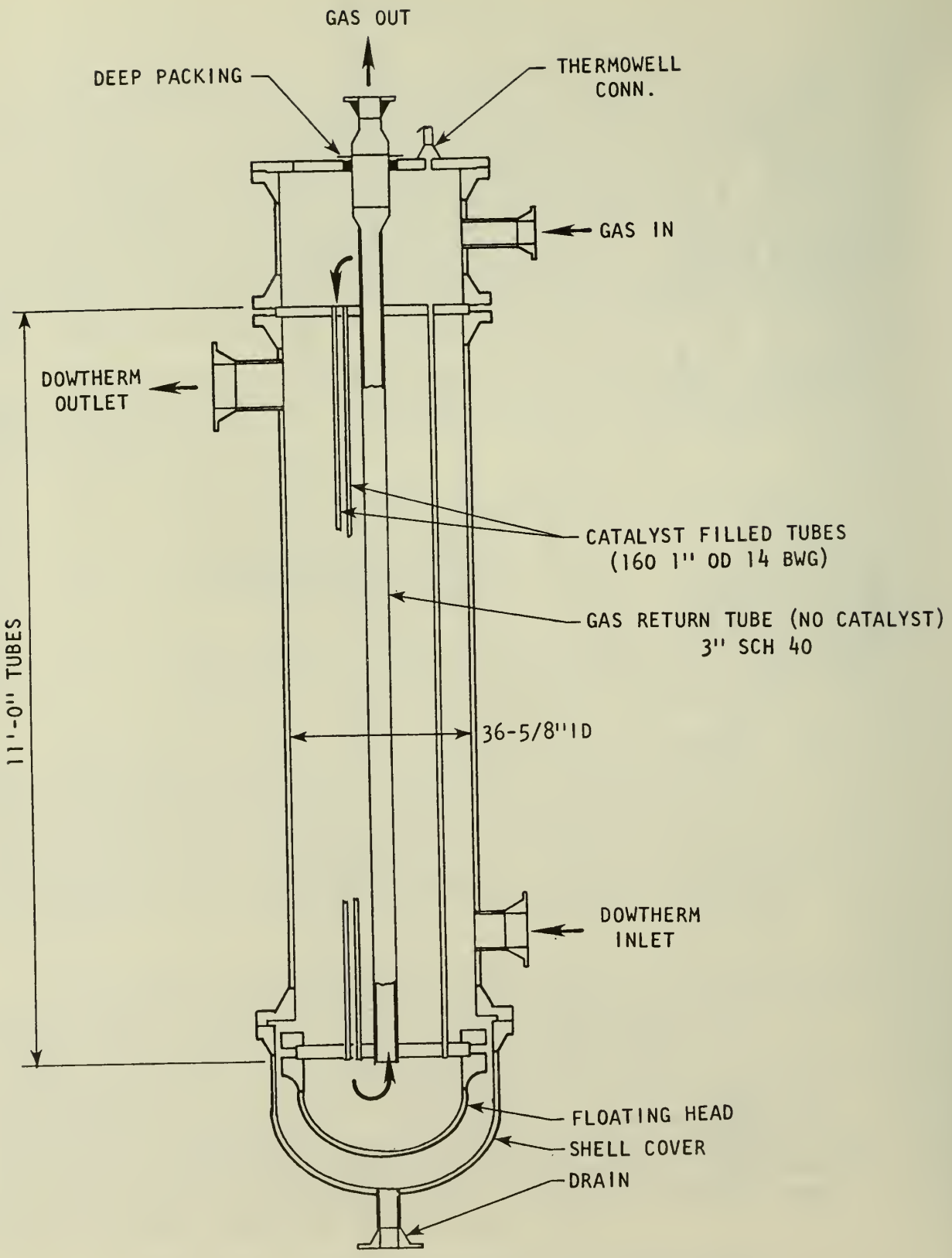

Figure 29-2. PACKED TUBE METHANATION REACTOR DESIGN

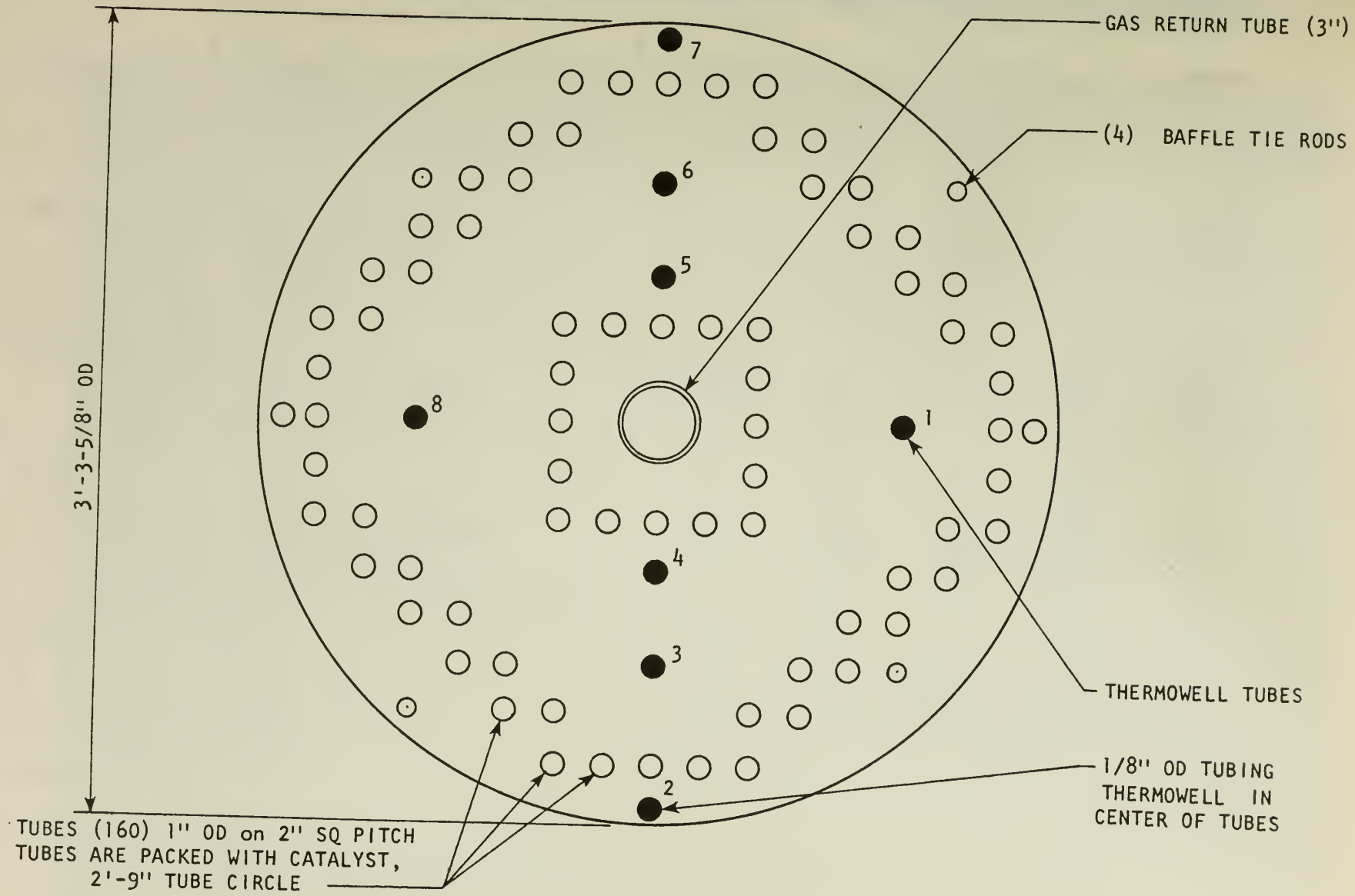

Figure 29-3. PACKED TUBE METHANATOR TUBE SHEET AND MOVABLE THERMOCOUPLE LAYOUT

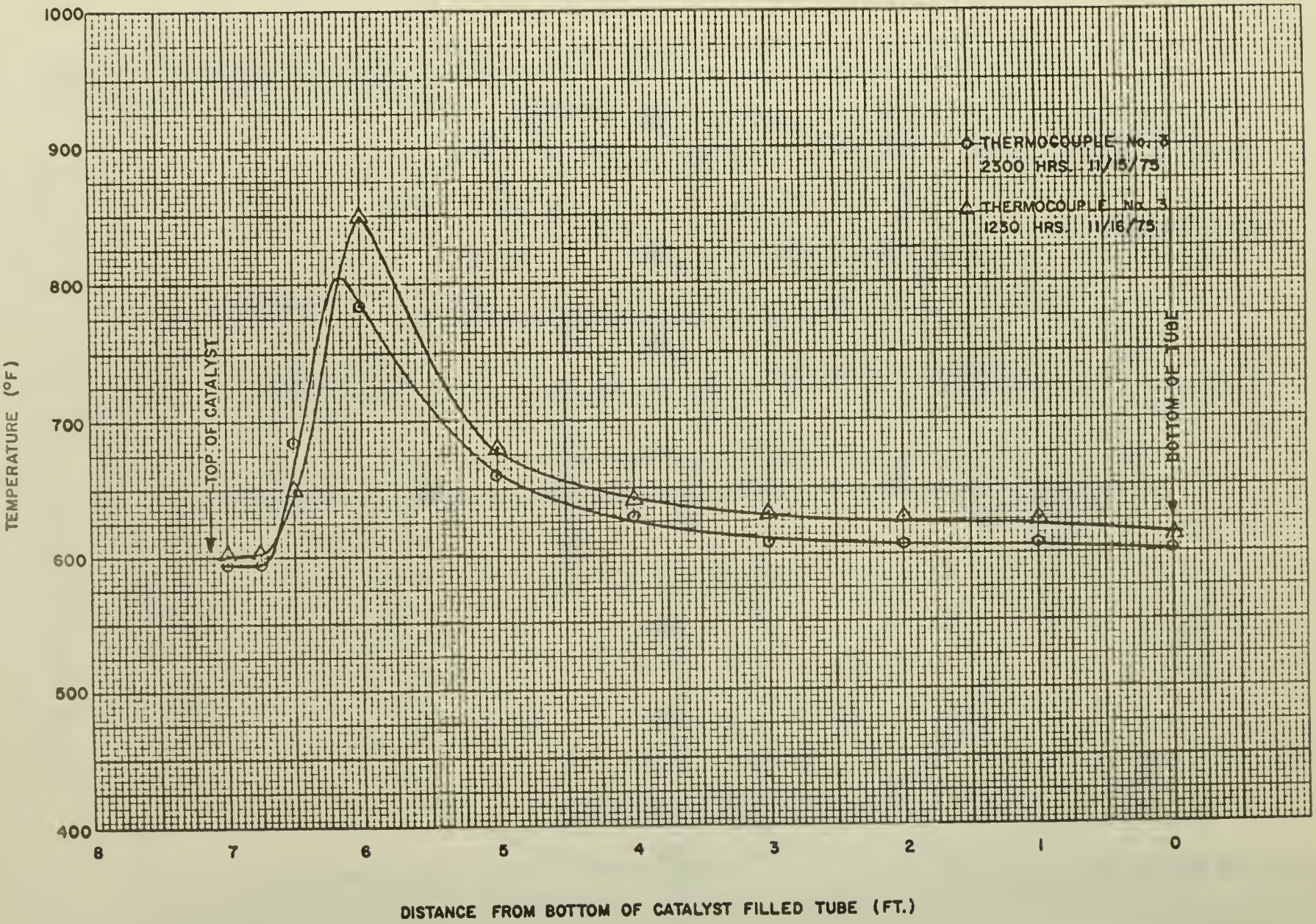

Figure 29-4. PACKED TUBE REACTOR TEMPERATURE PROFILES, RUN 29B

Date	10/23/75	← 10/24/75 →			10/25/75
Time	2300	0700	1500	2300	0700
Jacket Steam Make, lb/hr	0	0	0	0	0
Solids					
Feedstock	← Husky Char →		← Velva Lignite →		
Feed Rate, lb/hr[1]	1,440	1,440	1,800	2,090	1,440
Char Dump, lb/hr	-	-	-	-	-
Dump Acceptor, lb/hr	310	310	170	-	-
Gasifier Overhead Solids, lb/hr	220	190	230	230	-
Gas Flows[2]					
Boot (Recycle), SCFH	18,420	17,080	15,850	16,320	15,560
Boot (Steam), SCFH	18,070	17,980	21,430	24,770	24,960
CO_2 to Boot, SCFH	0	0	0	0	0
Steam to Side, SCFH	28,320	28,310	22,510	21,560	21,340
Air to Side, SCFH	20,490	20,220	20,060	19,950	20,090
Purges					
Recycle, SCFH	3,530	3,750	3,850	3,780	3,690
Inert, SCFH	230	230	230	230	230
Total Flow In, SCFH	89,100	87,600	83,900	86,600	85,900
Vent Rate, SCFH	52,210	64,430	72,020	73,020	69,130
Bed Conditions					
Boot Velocity, ft/sec	1.90	1.93	2.07	2.21	2.28
Char Bed Velocity, Inlet, ft/sec	0.88	0.90	0.87	0.88	0.91
Boot Density, lb/ft^3[3]	105	98	99	93	93
Char Bed Density, lb/ft^3[3]	47	42	37	36	31
Boot Temperature, °F	1356	1456	1478	1460	1507
Char Bed Temperature, °F	1370	1449	1476	1462	1508
Overhead Gas Compositions, Mol %					
CO	10.6	14.7	17.6	11.2	20.1
CO_2	19.6	17.5	14.7	15.7	12.6
N_2	37.1	30.1	23.8	24.7	32.5
H_2	28.4	32.8	35.7	36.1	31.8
CH_4	4.3	4.9	6.4	7.4	3.0

(1) Determined by feeder rpm
(2) Determined by orifice flow meter measurements
(3) Determined by differential pressure measurements

Table 29-1. GASIFIER DATA, RUN 29A

Date	10/23/75	← 10/24/75 →			10/25/75
Time	2300	0700	1500	2300	0700
Jacket Steam Make, lb/hr	100	200	210	300	300
Solids					
Acceptor Feedstock	← Dead-Burned Dolomite →				Limestone
Acceptor Makeup, lb/hr[1]	700	350	700	540	420
Acceptor Circulation, lb/hr[2]	4,300	4,700	5,300	6,900	8,900
Ash and Attrited Acceptor, lb/hr[3]	-	-	-	-	-
Auxiliary Fuel Char, lb/hr[1]	205	205	205	513	513
Gas Flows[4]					
Acceptor Lift, SCFH	62,540	62,170	57,560	52,970	56,740
Char Lift, SCFH	7,080	9,870	9,440	9,980	9,990
Air Line					
Recycle, SCFH	59,250	33,660	41,050	37,110	36,320
Air, SCFH	51,670	59,460	56,960	69,260	68,020
Purges					
Recycle, SCFH	1,820	1,810	1,810	1,820	1,790
Nitrogen, SCFH	1,990	1,540	1,680	2,840	2,050
Total Flow In, SCFH	184,400	168,500	168,500	174,000	174,900
Vent Rate, SCFH	57,090	68,550	71,190	73,440	73,710
Bed Conditions					
Gas Velocity, Inlet, ft/sec	3.05	3.06	3.07	3.16	3.22
Bed Density (Average), lb/ft^3[5]	95	96	90	92	96
Average Bed Temperature, °F	1627	1823	1837	1782	1867
Overhead Gas Analyses, Mol %					
O	0	0	0	0	0
CO	0	4.6	4.0	0	2.6
CO_2	16.8	18.4	18.4	16.8	22.5
N_2	81.1	77.1	77.6	83.2	74.9

(1) Determined by feeder rpm
(2) Determined by lift line pressure drop measurements
(3) Determined by weigh scale measurements
(4) Determined by orifice flow meter measurements
(5) Density indicated by pressure tap readings

Table 29-2. REGENERATOR DATA, RUN 29A

Date	← 11/13/75 →			← 11/14/75 →		
Time	0700	1500	2300	0700	1500	2300
Solids						
Feedstock	← Char →			← Velva Lignite →		
Feed Rate, lb/hr[1]	1,500	1,255	2,000	2,000	1,750	1,870
Char Withdrawal, lb/hr	277	260	200	204	385	160
Dump Acceptor, lb/hr	562	606	652	439	364	308
Gasifier Overhead Solids, lb/hr	135	202	152	254	147	99
Gas Flows[2]						
Boot (Recycle), SCFH	21,100	22,450	24,300	18,750	13,600	14,300
Boot (Steam), SCFH	16,800	17,850	17,900	25,300	31,000	30,950
CO_2 to Boot, SCFH	0	0	0	0	450	900
Steam to Side, SCFH	30,900	30,600	30,600	29,300	22,350	22,300
Air to Side, SCFH	19,800	20,500	19,100	11,800	4,250	4,200
Purges						
Recycle, SCFH	2,800	2,800	2,800	2,800	2,800	2,800
Inert, SCFH	160	160	160	160	160	160
Total Flow In, SCFH	91,600	94,400	94,900	88,100	74,600	75,600
Vent Rate, SCFH	50,500	55,300	69,500	60,200	49,100	49,300
Bed Conditions						
Boot Velocity, ft/sec	1.97	2.12	2,31	2.35	2.34	2.33
Boot Density, lb/ft^3[3]	104	104	102	96	93	93
Char Bed Density, lb/ft^3[3]	41	38	35	31	31	29
Boot Temperature, °F	1416	1479	1515	1525	1507	1516
Char Bed Temperature, °F	1408	1472	1505	1502	1492	1492
Overhead Gas Comppsitions, Mol %						
CO	13.0	16.1	18.8	16.5	14.7	14.8
CO_2	17.4	17.8	14.0	12.6	11.5	9.8
N_2	26.3	26.8	19.8	15.2	10.7	8.7
H_2	38.3	35.4	40.5	47.3	54.0	53.5
CH_4	4.9	4.0	6.9	8.4	9.1	10.9

(1) Determined by feeder rpm - lb/hr = (9.81)*(rpm)*(Bulk Density)
(2) Determined by orifice flow meter measurements
(3) Determined by differential pressure measurements

Table 29-3. GASIFIER DATA, RUN 29B (Sheet 1 of 2)

Date	11/15/75			11/16/75			11/17/75
Time	0700	1500	2300	0700	1500	2300	0700
Solids							
Feedstock	Velva Lignite						
Feed Rate, lb/hr[1]	2,000	2,000	2,300	2,350	2,350	2,350	2,350
Char Withdrawal, lb/hr	193	152	188	185	179	197	207
Dump Acceptor, lb/hr	262	270	252	210	258	233	417
Gasifier Overhead Solids, lb/hr	142	122	107	95	165	144	-
Gas Flows[2]							
Boot (Recycle), SCFH	16,200	12,300	9,300	0	0	0	0
Boot (Steam), SCFH	30,950	33,650	38,600	38,850	37,700	37,700	37,600
CO_2 to Boot, SCFH	900	900	900	900	900	900	900
Steam to Side, SCFH	22,300	19,300	19,500	19,500	15,600	15,700	15,800
Air to Side, SCFH	3,300	0	0	0	0	0	0
Purges							
Recycle, SCFH	2,800	2,800	4,340	3,140	2,830	2,510	2,862
Inert, SCFH	160	160	250	160	160	160	160
Total Flow In, SCFH	76,600	69,100	72,900	62,500	57,200	57,000	57,300
Vent Rate, SCFH	47,000	41,000	49,300	46,900	48,500	47,100	49,600
Bed Conditions							
Boot Velocity, ft/sec	2.41	2.35	2.15	2.10	2.10	2.0	2.1
Boot Density, lb/ft^3[3]	90	87	86	83	83	83	86
Char Bed Density, lb/ft^3[3]	30	35	34	34	35	33	33
Boot Temperature, ^oF	1529	1507	1475	1485	1489	1483	1499
Char Bed Temperature, ^oF	1494	1483	1468	1479	1484	1484	1495
Overhead Gas Compositions, Mol %							
CO	14.4	13.1	12.9	14.4	13.1	13.4	14.5
CO_2	10.8	11.3	10.4	10.8	9.6	11.1	9.6
N_2	7.8	2.9	3.6	7.8	3.5	3.1	2.8
H_2	55.8	59.6	59.8	55.8	60.1	58.6	59.9
CH_4	10.9	13.2	13.3	10.9	13.7	13.8	13.1

(1) Determined by feeder rpm - lb/hr = (9.81)*(rpm)*(Bulk Density)
(2) Determined by orifice flow meter measurements
(3) Determined by differential pressure measurements

Table 29-3. GASIFIER DATA, RUN 29B (Sheet 2 of 2)

Date	← 11/13/75 →			← 11/14/75 →		
Time	0700	1500	2300	0700	1500	2300
Jacket Steam Make, lb/hr	99	200	280	260	220	300
Solids						
Acceptor Feedstock	Dead-Burned Dolomite		←	Minnekahta Limestone		→
Acceptor Makeup, lb/hr(1)	720	720	560	560	560	560
Acceptor Circulation, lb/hr(2)	7,500	8,200	12,000	10,500	10,500	10,500
Ash and Attrited Acceptor, lb/hr(3)	-	-	-	-	-	-
Auxiliary Fuel Char, lb/hr(1)	348	348	202	403	330	367
Acceptor Activity			0.04	0.08	0.14	0.09
Gas Flows(4)						
Acceptor Lift, SCFH	56,900	57,100	56,500	56,100	56,000	56,200
Char Lift, SCFH	10,200	10,300	10,600	10,600	10,500	10,500
Air Line						
Recycle, SCFH	46,200	36,900	17,700	14,500	64,100	0
Air, SCFH	63,300	54,100	66,200	72,100	73,200	73,400
Purges						
Recycle, SCFH	2,200	2,200	2,200	2,200	2,200	2,200
Nitrogen, SCFH	1,520	1,570	1,390	1,140	1,000	1,220
Total Flow In, SCFH	180,300	162,200	154,600	156,600	207,000	143,500
Vent Rate, SCFH	68,700	61,600	75,000	85,100	89,600	89,500
Bed Conditions						
Gas Velocity, Inlet, ft/sec	3.24	2.97	2.83	2.85	3.80	2.61
Bed Density (Average), lb/ft^3(5)	96	96	93	89	88	77
Average Bed Temperature, ^oF	1800	1854	1854	1837	1842	1836
Overhead Gas Analyses, Mol %						
CO	4.25	2.97	3.84	2.69	4.04	3.06
CO_2	18.36	17.15	21.64	24.17	24.17	25.46
N_2	77.40	79.88	74.52	73.14	71.79	71.48

(1) Determined by feeder rpm
(2) Determined by lift line pressure drop measurements
(3) Determined by weigh scale measurements
(4) Determined by orifice flow meter measurements
(5) Determined by differential pressure measurements

Table 29-4. REGENERATOR DATA, RUN 29B (Sheet 1 of 2)

Date	← 11/15/75 →			← 11/16/75 →			11/17/75
Time	0700	1500	2300	0700	1500	2300	0700
Jacket Steam Make, lb/hr	300	250	200	320	380	300	300
Solids							
Acceptor Feedstock	← Minnekahta Limestone →						
Acceptor Makeup, lb/hr[1]	560	560	560	560	560	560	560
Acceptor Circulation, lb/hr[2]	10,500	10,500	10,500	10,500	10,500	10,500	10,500
Ash and Attrited Acceptor, lb/hr[3]	-	-	-	-	128	96	102
Auxiliary Fuel Char, lb/hr[1]	294	220	161	92	92	161	110
Acceptor Activity	0.11	0.13	0.15	0.17	0.15		0.13
Gas Flows[4]							
Acceptor Lift, SCFH	56,000	55,700	50,900	51,300	51,500	51,800	45,200
Char Lift, SCFH	10,400	10,400	10,400	10,500	10,500	10,600	10,500
Air Line							
Recycle, SCFH	0	0	0	0	0	0	0
Air, SCFH	76,400	73,400	77,200	79,800	80,800	81,900	82,400
Purges							
Recycle, SCFH	2,200	2,200	2,200	2,200	2,200	2,200	2,200
Nitrogen, SCFH	1,140	1,000	530	560	650	500	620
Total Flow In, SCFH	146,100	142,700	141,200	144,400	145,700	147,000	140,900
Vent Rate, SCFH	96,800	88,700	96,300	98,800	100,900	99,300	100,700
Bed Conditions							
Gas Velocity, Inlet, ft/sec	2.67	2.59	2.58	2.66	2.66	2.68	2.58
Bed Density (Average), lb/ft^3[5]	76	73	71	72	71	69	63
Average Bed Temperature, °F	1843	1834	1833	1856	1836	1833	1843
Overhead Gas Analyses, Mol %							
CO	4.04	1.81	3.44	2.15	2.06	3.16	2.24
CO_2	25.89	27.19	27.19	27.63	28.07	29.40	29.40
N_2	70.07	71.00	69.36	70.22	69.87	67.44	68.36

(1) Determined by feeder rpm
(2) Determined by lift line pressure drop measurements
(3) Determined by weigh scale measurements
(4) Determined by orifice flow meter measurements
(5) Determined by differential pressure measurements

Table 29-4. REGENERATOR DATA, RUN 29B (Sheet 2 of 2)

Run 29A

	Velva Lignite	Husky Char		Dead-Burned Dolomite
Date	10/24/75	10/24/75		10/11/75
Screen Size, Wt % Tyler Mesh			Screen Size, Wt % Tyler Mesh	
+20	11.5	20.4	+9	0.2
20 X 48	52.0	49.1	9 X 12	31.9
48 X 100	26.8	20.5	12 X 20	64.9
-100	9.7	10.1	20 X 28	2.2
			-28	0.7
Ultimate Analysis, Wt %				
Moisture	2.41	3.12		
C	66.86	69.79		
H + Moisture H	4.44	2.36		
S	0.50	1.46		
Ash + SO_3	7.48	17.67		

RUN 29B

	Velva Lignite	Velva Lignite	Auxiliary Char to Regenerator			Minnekahta Limestone
Date	11/14/75	←—	11/15/75	—→	11/16/75	Composite
Screen Size, Wt % Tyler Mesh					Screen Size, Wt % Tyler Mesh	
+10	0.7	0.7	1.5	0.2	+8	2.6
10 X 20	21.0	26.6	30.5	25.1	8 X 9	43.6
20 X 48	53.2	53.3	53.6	53.5	9 X 10	33.5
48 X 100	20.9	16.7	12.5	17.4	10 X 12	13.7
-100	4.2	2.7	1.9	3.8	12 X 14	4.5
					14 X 16	1.5
					16 X 20	0.3
					20 X 24	0.3
					24 X 28	Tr
					-28	Tr
Bulk Density, lb/cu ft	41.0					
% Sulfide						0.01
% Calcine Weight Change						-42.7
Ultimate Analysis, Wt %						
Moisture	1.52	1.52	2.62	1.94		
C	66.26	65.59	69.34	65.67		
H + Moisture H	3.81	4.55	2.40	4.61		
S	0.52	0.62	1.51	0.63		
Ash + SO_3	7.23	6.94	15.36	6.73		
Elemental Analysis, Wt %						
SiO_2						4.12
SO_3						0.09
Na_2O						0.03
CaO						93.94
MgO						0.87
K_2O						0.05
P_2O_5						0.04
Al_2O_3						1.05
Fe_2O_3						0.35
TiO_2						0.05

Table 29-5. FEEDSTOCK COMPOSITES, RUNS 29A AND 29B

S-9

Date	10/23/75	10/24/75		10/25/75
Time	2145	1200	2000	0400
Screen Size, Wt % Tyler Mesh				
+9	2.0	0.7	1.5	2.6
9 X 12	92.3	53.5	53.1	61.0
12 X 20	0.6	44.6	43.9	34.6
20 X 28	2.8	1.2	0.9	1.0
-28	2.3	Tr	0.6	0.8

S-10

Date	10/23/75	10/24/75		10/25/75	
Time	2200	0800	1600	0000	0800
Screen Size, Wt % Tyler Mesh					
+8		Tr			Tr
8 X 9	0.7	0.9	0.4	0.4	1.4
9 X 10		11.2			10.1
10 X 12	36.1	28.3	41.4	40.5	25.5
12 X 14		30.3			28.7
14 X 16		20.7			28.7
16 X 20	59.2	5.4	54.9	53.8	4.8
20 X 24		1.0			0.7
24 X 28	2.3	0.5	2.2	1.8	Tr
-28	1.6	1.7	1.1	3.4	0.3

Table 29-6. CALCINED ACCEPTOR (S-9) AND RECARBONATED ACCEPTOR (S-10), RUN 29A

	S-9					S-10				
Date	11/13/75	11/14/75	11/15/75	11/16/75	11/17/75	11/13/75	11/14/75	11/15/75	11/16/75	11/17/75
Time	0800	0800	0800	0800	0800	0800	0800	0800	0800	0800
Screen Size, Wt % Tyler Mesh										
+6	+	0.4	0.4	+	+	+	0.2	+	+	+
6 X 8	0.4	5.1	4.3	7.9	10.0	Tr	2.1	5.3	9.2	13.7
8 X 9	0.9	5.5	7.2	12.1	15.3	0.5	2.9	10.5	16.1	20.3
9 X 10	11.6	14.6	18.3	23.1	21.9	8.7	13.5	22.9	27.4	26.1
10 X 12	36.0	29.5	25.5	22.4	18.5	31.6	31.4	25.4	20.8	16.6
12 X 14	30.3	27.1	26.0	18.1	13.4	33.6	30.0	22.3	16.1	10.8
14 X 16	16.0	13.0	10.3	5.5	5.4	20.1	15.9	8.6	4.5	3.8
16 X 20	3.6	2.6	3.0	2.9	3.9	4.8	3.4	2.3	1.8	24.5
20 X 24	0.6	0.7	1.3	2.2	3.2	0.6	0.6	1.0	1.1	1.6
24 X 28	0.2	0.4	0.9	2.9	3.2	0.1	0.3	0.4	1.1	1.6
-28	0.4	1.2	2.8	3.0	5.3	0.1	0.8	1.2	1.9	2.9
Particle Density, lb/cu ft							188	158	146	129
Activity							0.08	0.11	0.17	0.13
% Sulfide	0.09	0.04	0.03	0.06	0.06	0.05	0.02	0.03	0.05	
% Calcine Weight Change	-0.2	-0.2	-0.2	-1.9	-2.5	-2.2	-5.0	-7.8	-9.6	
Elemental Analysis, Wt %										
SiO_2	1.41	2.56	4.67	5.92	6.22	2.11	2.78	4.77	5.59	
SO_3	0.25	0.07	0.13	0.11	0.10	0.16	0.10	0.12	0.15	
Na_2O	0.02	0.04	0.08	0.09	0.13	0.02	0.03	0.06	0.07	
CaO	58.82				83.02	57.71				
MgO	37.57				7.07	37.44				
K_2O	0.01				0.04	0.01				
P_2O_5	0.01				0.03	0.01				
Al_2O_3	0.75				2.62	1.25				
Fe_2O_3	1.50				1.31	1.37				
TiO_2	0.08				0.09	0.07				

Table 29-7. CALCINED ACCEPTOR (S-9) AND RECARBONATED ACCEPTOR (S-10), RUN 29B

Date	11/13/75		11/14/75		11/14/75		11/14/75		11/15/75		11/15/75	
Time	2040		0400		1200		2000		0400		1200	
Sample	Mix	Acc.	Mix	Acc.	Mix	Acc.	Mix	Acc.	Mix	Acc.	Mix	Acc.
Screen Size, Wt %												
Tyler Mesh												
+8	Tr	0.1	0.3	0.5	1.1	3.4	1.3	1.9	1.3	1.6	3.0	2.0
8 X 9		0.7		5.0		5.8		4.6		9.2		11.9
9 X 10	2.5		3.1		6.3		8.6		6.6		13.5	
10 X 12		44.3		40.9		46.5		37.2		34.3		42.6
12 X 14	24.5	21.4	27.3	20.0	24.3	15.2	24.5	18.6	22.0	16.0	31.2	13.0
14 X 20	16.5	23.2	13.7	18.5	11.7	15.7	9.8	15.4	9.4	13.6	10.3	10.7
20 X 28	14.4	1.9	9.9	2.2	9.4	2.5	7.7	4.0	8.6	4.9	8.1	5.4
28 X 35	15.4		13.1		13.3		12.2		12.2		9.6	
35 X 48	3.6		4.4		0.7		8.7		7.0		10.7	
48 X 65	17.2	7.0	19.3	11.2	24.2	10.2	17.4	17.3	19.3	19.1	7.3	13.7
65 X 80		0.7		1.5		0.5		0.6		1.2		0.3
80 X 100	4.6		6.4		6.6		7.6		8.6		4.8	
100 X 200	1.3		2.2		2.0		2.1		3.7		1.5	
-200	Tr	0.6	0.2	0.2	0.3	0.1	Tr	0.2	1.2	0.2	Tr	0.2
% Acceptor	40.0		45.3		51.7		44.3		41.8		61.1	
% Char in Ash	17.03		15.48		16.51		17.68		16.17		14.90	
Ash Elemental Analysis, Wt%												
SiO_2			21.85						19.12			
SO_3			2.49						1.49			
Na_2O			1.64						1.47			

Table 29-8. GASIFIER CHAR BED MATERIAL, RUN 29B (Sheet 1 of 2)

Date	11/15/75		11/16/75		11/16/75		11/16/75		11/17/75	
Time	2000		0400		1200		1940		0400	
Sample	Mix	Acc.	Mix	Acc.	Mix	Acc.	Mix	Acc.	Mix	Acc.
Screen Size, Wt % Tyler Mesh										
+8	3.9	6.8	3.9	7.2	5.7	13.4	3.0	7.8	4.7	11.6
8 X 9		15.2		13.6		16.4		15.8		17.3
9 X 10	14.6		15.3		15.4		14.5		14.1	
10 X 12		37.3		32.9		33.8		40.1		32.3
12 X 14	21.9	12.7	22.5	18.0	21.8	9.4	19.0	11.6	17.8	7.7
14 X 20	9.3	9.6	8.5	9.6	8.6	7.0	7.2	10.1	8.4	7.4
20 X 28	9.6	5.6	9.0	6.6	9.3	5.9	9.5	8.4	10.3	7.3
28 X 35	10.3		10.3		10.9		12.4		11.6	
35 X 48	11.7		11.7		11.8		14.2		13.1	
48 X 65	9.2	11.8	8.5	14.6	8.5	12.9	10.6	5.4	9.7	15.1
65 X 80		1.1		1.4		0.9		0.5		0.9
80 X 100	6.7		6.1		5.7		7.0		7.1	
100 X 200	2.6		2.8		1.9		2.6		2.7	
-200	0.2	Tr	1.4	Tr	0.4	0.2	0.1	0.3	0.3	0.3
% Acceptor	46.0		52.5		46.4		52.8		49.6	
% Char in Ash	11.68		12.49		13.05		15.31		12.80	
Ash Elemental Analysis, Wt %										
SiO_2			16.67							
SO_3			2.23							
Na_2O			1.08							

Table 29-8. GASIFIER CHAR BED MATERIAL, RUN 29B (Sheet 2 of 2)

Date	11/13/75	11/13/75		11/14/75		11/14/75		11/14/75		11/14/75		11/15/75	
Time	0800	1840		0000		0900		1430		2215		0730	
Sample	Mix	Mix	Acc.	Mix	Acc.	Mix	Acc.	Mix	Acc.	Mix	Acc.	Mix	Acc.
Screen Size, Wt %													
Tyler Mesh													
+8		Tr	0.1			0.3	1.4	0.9	3.9	1.0	2.0	0.6	1.1
8 X 9			1.0		0.5		4.1		6.8		6.4		4.4
9 X 10	2.0	3.4		2.7		3.5		8.7		12.7		4.3	
10 X 12			49.0		44.9		33.8		34.8		40.8		2.9
12 X 14	25.4	31.7	21.4	32.4	22.9	17.6	18.6	21.8	18.5	33.0	19.5	18.4	13.3
14 X 20	17.2	16.8	20.7	19.1	23.4	14.9	19.6	12.9	19.2	10.3	14.8	12.0	15.7
20 X 28	16.3	13.2	1.4	14.5	1.7	16.9	4.4	16.0	3.8	7.0	4.0	14.8	8.2
28 X 35	16.2	14.7		14.6		19.9		16.6		11.4		19.9	
35 X 48	6.5	4.0		2.0		5.7		8.2		10.7		17.5	
48 X 65	12.5	13.5	5.7	12.7	6.0	17.7	16.9	12.2	11.4	9.8	10.1	8.6	26.3
65 X 80			0.4		0.5		0.7		0.8		2.3		1.5
80 X 100	3.4	2.6		1.8		3.1		2.6		3.5		3.6	
100 X 200	0.6	0.2		0.1		0.3		0.1		0.5		0.4	
-200	Tr	Tr	0.3	Tr	0.2	Tr	0.7	Tr	0.7	Tr	Tr	Tr	0.7
% Acceptor		57.8		54.6		25.4		52.9		64.5		38.9	
% Char in Ash		21.00		18.54		15.90		16.81		15.18		9.72	
Ash Elemental Analysis, Wt %													
SiO_2						17.33						17.00	
SO_3						2.06						2.41	
Na_2O						1.47						1.46	

Table 29-9. PURGED CHAR, RUN 29B (Sheet 1 of 2)

Date	11/15/75		11/16/75		11/16/75		11/16/75		11/17/75		11/17/75		11/17/75	
Time	1705		0330		0915	0400	1720		0500		0830		1650	
Sample	Mix	Acc.	Mix	Acc.	Mix	Acc.	Mix	Acc.	Mix	Acc.	Mix	Acc.	Mix	Acc.
Screen Size, Wt %														
Tyler Mesh														
+8	3.3	2.3	1.2	5.1	1.6	6.2	3.8	15.9	12.9	23.1	7.4	11.4	4.1	8.9
8 X 9		7.2		8.7		9.9		17.5		24.0		17.0		11.3
9 X 10	14.2		9.0		7.5		16.1		28.6		18.9		12.5	
10 X 12		39.7		26.8		25.6		37.5		30.3		31.4		23.9
12 X 14	27.9	15.4	23.6	12.1	17.9	12.7	22.8	8.0	29.4	6.3	23.4	8.4	14.9	5.4
14 X 20	11.3	11.2	12.8	14.0	10.5	12.9	9.9	7.6	7.3	5.2	9.4	8.3	9.0	8.1
20 X 28	11.0	6.6	14.2	11.1	14.1	13.1	12.8	5.4	6.4	3.9	10.5	7.6	14.1	10.9
28 X 35	11.9		15.9		18.5		13.2		6.0		11.0		17.4	
35 X 48	11.5		13.4		16.5		11.8		5.5		10.2		15.8	
48 X 65	6.0	17.1	6.6	21.3	8.6	14.5	6.2	7.4	2.8	6.9	5.6	15.0	7.9	31.0
65 X 80		0.3		0.4		3.2		0.3		0.1		0.6		0.5
80 X 100	2.6		2.9		4.1		2.9		1.1		3.9		3.6	
100 X 200	0.4		0.4		0.7		0.4		Tr		0.5		0.6	
-200	Tr	0.1	Tr	0.4	0	1.8	Tr	0.3	Tr	Tr	Tr	0.3	Tr	0.1
% Acceptor	68.5		55.7		42.7		66.3		76.8		53.7		59.5	
% Char in Ash	14.84		10.85		9.95		10.04		7.20		8.91		12.43	
Ash Elemental Analysis, Wt %														
SiO_2					14.06									
SO_3					2.47									
Na_2O					1.25									

Table 29-9. PURGED CHAR, RUN 29B (Sheet 2 of 2)

	Run 29A		Run 29B		
Date	10/24/75	11/13/75	11/14/75	11/15/75	11/16/75
Screen Size, Wt %					
Tyler Mesh					
+60	1.8	4.5			
60 X 100	26.2	22.0			
100 X 325	38.1	35.0			
-325	33.8	38.5			
Ultimate Analysis, Wt %					
C	64.78		58.88	66.92	67.97
H	1.01		1.92	1.00	1.27
S (Total)	1.43		0.73	0.64	0.62
Ash + SO_3	27.92		22.98	23.83	22.50
H_2O	-		-	-	1.21

Table 29-10. GASIFIER QUENCH TOWER SOLIDS (COMPOSITES), RUNS 29A AND 29B

Run	29A			29B		
Date	10/25/75	←	11/15/75	→	11/16/75	11/17/75
Time	0530	←	0000	→	2030	1815	0300
Sample	B	A	B	A	A	B
Screen Size, Wt % Tyler Mesh						
+35	1.4	0.2	1.2	Tr	Tr	5.8
35 X 48	6.3	1.6	4.6	Tr	Tr	4.7
48 X 65	10.6	4.5	11.4	0.1	Tr	8.0
65 X 100	15.0	7.1	18.1	0.3	Tr	12.2
100 X 200	23.3	10.1	25.3	1.3	1.2	23.1
200 X 325	12.8	4.9	11.9	12.7	7.9	15.3
-325	30.5	71.5	27.4	85.7	90.9	30.9

Table 29-11. ASH AND ATTRITED ACCEPTOR SIZE ANALYSES, RUNS 29A AND 29B

Date	11/15/75	11/15/75	11/15/75	11/16/75	11/16/75	11/16/75	11/17/75
Time	1100	1500	2300	0700	1500	2300	0700
Carbonate Tower							
Feed Gas, SCFH (Wet)	33,671	33,308	33,670	32,818	33,547	33,070	33,048
Feed Gas, SCFH (Dry)	33,194	33,134	33,513	32,673	33,396	32,963	32,913
Temperature, °F	93	93	88	86	87	77	83
Pressure, PSIG	133	133	127	126	128	128	124
Compositions, Mol %							
H_2 (Dry)	59.60	59.54	59.80	59.70	60.10	58.89	59.96
N_2 (Dry)	3.90	2.90	3.60	3.10	3.50	3.12	2.80
CO (Dry)	13.80	13.09	12.90	13.30	13.10	13.47	14.51
CH_4 (Dry)	13.10	13.19	13.30	13.00	13.70	13.37	13.11
CO_2 (Dry)	9.60	11.29	10.40	10.90	9.60	11.16	9.61
H_2O	0.52	0.52	0.47	0.44	0.45	0.33	0.41
MW (Wet)	12.51	12.79	12.56	12.70	12.31	12.90	12.42
HHV, BTU/SCF (Dry)	370	368	369	367	375	369	373
Methanator Feed							
Feed Gas, SCFH (Wet)	15,596	22,102	21,078	22,244	26,765	26,847	26,596
Feed Gas, SCFH (Dry)	15,017	20,643	19,082	20,759	25,147	25,474	25,210
Temperature, °F (1)	394	618	697	697	688	684	685
Temperature, °F (2)	461	480	518	518	506	515	517
Temperature, °F (3)	537	561	583	582	595	608	608
Pressure, PSIG	104	104	104	105	105	105	104
Compositions, Mol %							
H_2 (Dry)	65.57	64.40	64.74	67.00	66.27	65.70	65.80
N_2 (Dry)	4.60	5.10	4.60	3.10	3.20	3.90	3.60
CO (Dry)	12.01	10.90	9.09	10.10	10.51	11.00	11.50
CH_4 (Dry)	14.21	13.50	14.09	14.30	14.81	14.80	14.20
CO_2 (Dry)	3.60	6.10	7.49	5.50	5.21	4.60	4.90
H_2O*	3.71	6.60	9.47	6.68	6.05	5.11	5.21
MW (Wet)	10.15	11.12	11.39	10.31	10.34	10.31	10.41
HHV, BTU/SCF (Dry)	395	380	381	394	398	398	394
Recycle Rate							
Feed Gas, SCFH (Wet)	39,820	42,661	40,674	42,434	43,537	42,521	43,226
Feed Gas, SCFH (Dry)	39,705	42,525	40,566	42,299	43,413	42,445	43,152
Temperature, °F	133	130	128	127	134	127	125
Pressure, PSIG	130	130	125	130	135	135	140
Compositions, Mol %							
H_2 (Dry)	22.50	28.50	26.17	27.30	30.10	24.40	23.70
N_2 (Dry)	14.30	6.10	10.39	6.40	6.60	6.40	6.00
CO (Dry)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CH_4 (Dry)	63.20	65.40	63.44	66.30	63.30	69.20	70.30
CO_2 (Dry)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H_2O	0.29	0.32	0.27	0.32	0.28	0.18	0.17
MW (Wet)	14.61	12.79	13.63	13.00	12.63	13.39	13.44
HHV, BTU/SCF (Dry)	711	753	726	758	737	778	787
Adiabatic Reactor							
Feed Gas, SCFH (Wet)	14,813	9,110	9,155	8,747	10,240	10,068	10,059
Feed Gas, SCFH (Dry)	14,771	9,081	9,130	8,719	10,211	10,050	10,042
Temperature, °F	65	67	62	67	63	50	49
Pressure, PSIG	93	90	90	90	87	87	87
Compositions, Mol %							
H_2 (Dry)	22.50	28.50	26.17	27.30	30.10	24.40	23.70
N_2 (Dry)	14.30	6.10	10.39	6.40	6.60	6.40	6.00
CO (Dry)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CH_4 (Dry)	63.20	65.40	63.44	66.30	63.30	69.20	70.30
CO_2 (Dry)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H_2O	0.29	0.32	0.27	0.32	0.28	0.18	0.17
MW (Wet)	14.61	12.79	13.63	13.00	12.63	13.39	13.44
HHV, BTU/SCF (Dry)	711	753	726	758	737	778	787
Water Make, lb/hr	NA	NA	NA	NA	NA	NA	NA
Dowtherm Circulation Rate, lb/hr	83,480	73,860	82,080	82,050	81,600	81,180	81,070
Temperature to DC-402, °F	572	592	615	616	629	641	644
Temperature from DC-402, °F	555	585	620	620	630	645	650
Dowtherm Condensed, lb/hr	1,560	1,390	1,680	1,800	1,390	1,880	2,460

*NOTE: The percent moisture was determined assuming water-gas shift equilibrium at 925°F.

(1) Temperature of flow measuring orifice.
(2) Temperature of fresh feed gas plus recycle at reactor inlet.
(3) Temperature of reactor effluent.

Table 29-12. METHANATOR PROCESS FLOWS, RUN 29B

Date	Time, Hours	Tube	Distance From Bottom of Tube, ft. Temperature, °F 0	1	2	3	4	4.5	5	5.5	6	6.25	6.50	5.75	7.0
11/15/75	1110	2	545	570	580	575	587	-	615	-	698	-	-	-	545
	1415	2	563	583	586	591	598	607	614	639	677	718	758	735	-
	2300	2	598	606	607	610	630	-	660	-	790	-	665	595	590
	2300	3	602	607	607	610	628	-	660	-	785	-	690	595	595
	2300	6	607	607	610	615	650	-	730	-	600	-	605	600	608
	2300	8	603	607	609	612	632	-	665	-	790	-	600	595	595
11/16/75	1230	2	608	625	627	631	645	-	680	-	832	-	665	601	600
	1230	3	612	625	627	631	642	-	680	-	848	-	650	601	600
	1230	6	612	627	-	634	650	-	695	-	835	-	638	610	615
	1230	8	615	629	630	634	648	-	685	-	853	-	647	607	605

Date	Time, Hours	Tube	Dowtherm Circulation Rate, lb/hr	Dowtherm Inlet Temperature In-Out, °F
11/15/75	1110	2	83,700	570-565
	1415	2	83,200	585-582
	2300	2	82,200	615-620
	2300	3	82,200	615-620
	2300	6	82,200	615-620
	2300	8	82,200	615-620
11/16/75	1230	2	81,600	630-635
	1230	3	81,600	630-635
	1230	6	81,600	630-635
	1230	8	81,600	630-635

Table 29-13. PACKED TUBE METHANATOR TEMPERATURE PROFILES, RUN 29B

RUN 30

NOVEMBER 26 TO DECEMBER 7, 1975

CO_2 ACCEPTOR PROCESS GASIFICATION

PILOT PLANT

RAPID CITY, SOUTH DAKOTA

1 SUMMARY

Run 30 consisted of a single vessel operation in which the regenerator system was isolated from the gasifier. The reactor was filled with a batch of dead-burned dolomite and brought to operating temperature by burning Husky char in the fluidized acceptor bed. The char was supplied to the reactor from the auxiliary char system. The run lasted 188 hours during which three balance periods were obtained. Sufficient heat and material balance data were collected to calculate a heat loss on the regenerator system. The run was voluntarily ended. Afterward, inspection of the regenerator revealed no deposits.

2 TEST DATA

Run 30 data are presented graphically and/or tabularly at the end of this run report. These tables include:

		Page
Table 30-1.	Regenerator Data for Run 30 (8 sheets)	116
Table 30-2.	Char Compositions for Run 30	124
Table 30-3.	Ash Lockhopper for Run 30	125
Table 30-4.	Ash Compositions for Run 30 (2 sheets)	126
Table 30-5.	Ash Size Distribution and Elemental Analysis, for Run 30 (4 sheets)	128
Table 30-6.	Heat and Material Balance Data for Run 30	132
Table 30-7.	Regenerator Inventory for Run 30	133

3 SIGNIFICANT EVENTS AND OBSERVATIONS

3.1 OBJECTIVE

The primary objective of Run 30 was to collect heat and material balance data on the isolated regenerator system in order to obtain a more accurate estimate of heat loss from the regenerator.

It was also decided to check out the operation of the turbine test stand during this run, since it could not interfere with the operation of the gasifier.

3.2 RUN PROCEDURE

The regenerator was isolated from the gasifier system by installing blinds in all lines between the gasifier and the regenerator. A normal operating level of dead-burned dolomite was established in the regenerator. The regenerator was then heated up to 1860°F by combustion of char which was fed via the auxiliary char feed system.

After the regenerator bed temperature reached 1860°F, the fuel and air rates were held constant for a period of 48 hours during which heat and material balance data were collected.

For two other balance periods, the recycle gas preheat temperature was reduced from 1400°F to 1100°F and to 600°F respectively. Fuel and air were adjusted to compensate for the reduced temperature of the recycle gas.

3.3 ACCOMPLISHMENTS

All objectives of the run were achieved with no operational problems encountered. The regenerator was operated for a total of 188 hours at process conditions during which all necessary heat and material balance data were obtained. The turbine test stand was operated on regenerator flue gas for a period of approximately 127 hours during which dust loading and pressure drop data were obtained.

3.4 MODIFICATIONS AND CHANGES MADE PRIOR TO RUN 31

After the scheduled shutdown of Run 30, the gasifier was prepared for batch operation to obtain heat and material balance data and also to test the operability of subbituminous and preoxidized subbituminous coal as feedstocks.

3.5 CHRONOLOGY OF OPERATIONS

Date	Time	Description
11/26	1649	Pressure testing system.
11/27	0800	Started refractory cure for patchwork done in regenerator.
11/28	1000	Refractory cure complete.
"	2140	Started filling regenerator with dead-burned dolomite.
11/29	0540	Regenerator bed established.
"	0935	Started auxiliary fuel char to regenerator.
"	1300	Regenerator at 1850°F, lining out auxiliary fuel char and air flow.
"	1725	Initiating balance period No. 1.
12/1	1313	Put Elliott test stand in service.
12/2	1153	Ending balance period No. 1
"	1600	Took Elliott test stand out of service.
"	2130	Increasing flow to regenerator in an effort to elutriate accumulated ash.
"	2355	Lowering B-205 lift gas heater temperature for second balance period.
12/3	0230	Put Elliott test stand back in service.
"	0830	Initiating balance period No. 2.
12/4	0800	Lowering B-205 lift gas heater for third balance period.
"	1130	Ending balance period No. 2.
"	1200	Initiating balance period No. 3.
12/7	0828	Ending balance period No. 3.
"	0900	Took Elliott test stand out of service, preparing system for shutdown.

4 RESULTS AND DISCUSSION

4.1 BACKGROUND

The reoccurrence of gasifier upsets related to the reject acceptor lockhopper which ended Run 29B led to the decision to discontinue use of the hopper. In future runs, spent acceptor would be purged from the regenerator rather than from the gasifier boot. Runs 30, 31, and 32 were designed to provide plant data while the new reject acceptor lockhopper was being installed.

Run 30 was designed primarily to obtain heat and material balance data from which a more accurate estimate of the total heat loss from the regenerator system could be calculated. Run 30 also provided the opportunity to test the operation and sampling procedures for the stationary turbine blade test stand. The test stand was installed to provide information for the design of expander type power recovery units for commercial processes.

No operational problems were encountered during any part of the run. Prior to the start of the first balance period, the bed pressure drop indicated that the regenerator inventory was increasing. This was confirmed after examining the analysis of the inlet and outlet solid streams and calculating an ash balance. Prior to the start of the second balance period, the accumulated ash in the regenerator bed was elutriated by increasing the gas velocity from 2.6 FT/SEC to 3.2 FT/SEC for several hours. During the second and third balance periods, the bed velocity was maintained at 2.8 FT/SEC or greater, which apparently increased acceptor elutriation and caused the bed level to decrease.

4.2 PLANT DATA

Table 30-1 lists the specific regenerator operating conditions for the three balance periods. Balance period No. 1 was narrowed to a twelve-hour period in order to avoid the time period in which the regenerator inventory was increasing due to ash accumulation.

Table 30-2 lists the ultimate analysis of every tote bin of Husky char fed throughout the run.

Table 30-3 lists all the ash lockhopper dumps throughout the run. Ultimate and elemental analysis of the particular ash samples removed during balance periods are shown in Table 30-4 and 30-5. A summary of the average values of all the data is listed in Table 30-6. Table 30-7 lists the regenerator inventory throughout the run at four hour intervals. The regenerator inventory was approximated by using the following equation:

$$W = \frac{gc}{g} A * \Delta P$$

Where: A = The regenerator cross-sectional area, ft^2
g = Acceleration of gravity, ft/sec^2
gc = Newton's law conversion factor, $ft\text{-}lb/(lb_f\text{-}sec^2)$
ΔP = Differential pressure across the fluidized regenerator bed, lb_f/ft^2
W = Weight of fluidized bed, lb

Heat and material balances have not been provided, since this is beyond the present scope of this data report.

5 FUTURE PLANS

Run 31 will be conducted using only the gasifier reactor. The run is designed to test the need for subbituminous coal pretreatment prior to using the coal as a gasifier feedstock. The run will also provide additional data on gasifier heat losses and should provide some information on the steam-carbon gasification kinetics.

Date	11/30					12/1				
Time	2400	0200	0400	0600	0800	1000	1200	1400	1600	1800
Preheat Temperatures										
Acceptor Lift, °F	1230	1235	1230	1230	1230	1235	1225	1230	1230	1235
Air and Recycle, °F	740	830	830	835	835	830	830	835	830	830
Char Lift, °F	730	735	735	760	755	755	750	750	750	750
Char Feed, Average Rate, lb/hr(1)	325	325	325	325	325	325	325	325	325	325
Ash Lockhopper, Average Rate, lb/hr(1)	40.7	44.7	44.7	44.7	44.7	51.0	51.0	51.0	51.0	54.1
Gas Flows(2)										
Acceptor Lift, SCFH	57,300	57,100	56,000	56,000	55,600	55,800	55,900	56,200	56,100	56,300
Char Lift, SCFH	7,600	7,600	7,600	7,600	7,600	7,600	7,600	7,600	7,600	7,600
Air Line										
Recycle, SCFH	40,400	40,300	40,300	40,300	40,000	40,100	40,200	40,300	40,300	40,500
Air, SCFH	33,300	33,200	33,300	33,700	33,400	33,800	32,300	33,000	33,900	33,900
Purges										
Recycle, SCFH	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
Elliott Test Fixture, SCFH	0	0	0	0	0	0	0	9,000	9,000	9,000
Vent Rate, SCFH	32,600	30,500	30,500	31,100	29,400	29,600	29,900	21,600	23,000	23,700
Total Flow Out, SCFH	32,600	30,500	30,500	31,100	29,400	29,600	29,900	30,600	32,000	32,700
Bed Conditions										
Gas Velocity Inlet, ft/sec	2.62	2.62	2.60	2.61	2.60	2.63	2.57	2.58	2.63	2.64
Bed Density, lb/ft3(3)	105	105	105	105	105	106	105	105	107	107
Average Bed Temperature, °F	1841	1846	1844	1851	1853	1866	1838	1830	1856	1861
Overhead Gas Analyses, Mol %										
CO(4)	3.94	3.54	3.25	3.44	3.16	2.60	3.74	4.35	3.84	4.04
CO_2(4)	18.76	18.76	18.76	18.76	18.36	18.96	17.95	17.55	17.15	17.55
N_2	77.10	77.50	77.89	77.70	78.38	78.24	78111	77.90	78.81	78.21
H_2	0.20	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2

(1) Determined by weigh scale measurements
(2) Determined by orifice flow meter measurements
(3) Density indicated by pressure tap readings
(4) Determined by continuous analyzer

Table 30-1. REGENERATOR DATA FOR RUN 30 (Sheet 1 of 8)

	← Balance Period No. 1 →								
Date	← 12/1 →			← 12/2 →					
Time	2000	2200	2400	0200	0400	0600	0800	1000	1200
Preheat Temperatures									
Acceptor Lift, °F	1230	1225	1225	1225	1225	1225	1230	1225	1230
Air and Recycle, °F	830	830	815	835	830	830	830	830	835
Char Lift, °F	750	750	750	760	740	760	750	750	755
Char Feed, Average Rate, lb/hr(1)	325	325	325	325	325	325	325	325	325
Ash Lockhopper, Average Rate, lb/hr(1)	54.1	54.1	54.1	72.9	72.9	72.9	72.9	72.9	72.9
Gas Flows(2)									
Acceptor Lift, SCFH	56,200	56,100	55,900	56,000	56,000	56,000	55,800	55,800	55,900
Char Lift, SCFH	7,600	7,600	7,600	7,600	7,600	7,600	7,600	7,600	7,600
Air Line									
Recycle, SCFH	40,400	40,300	40,200	40,200	40,300	40,200	40,100	40,100	40,200
Air, SCFH	33,900	3,300	33,200	34,100	33,000	33,000	32,700	30,600	32,700
Purges									
Recycle, SCFH	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
Elliott Test Fixture, SCFH	9,000	9,000	9,000	8,600	8,100	8,900	8,900	12,400	8,600
Vent Rate, SCFH	22,900	22,900	22,800	22,900	25,600	24,900	24,100	22,000	22,700
Total Flow Out, SCFH	31,900	31,900	31,800	31,500	33,700	33,800	34,000	34,400	31,300
Bed Conditions									
Gas Velocity Inlet, ft/sec	2.64	2.63	2.63	2.63	2.62	2.61	2.60	2.53	2.60
Bed Density, lb/ft^3(3)	107	107	107	105	105	107	107	107	107
Average Bed Temperature, °F	1862	1864	1876	1857	1870	1861	1861	1836	1859
Overhead Gas Analyses, Mol %									
CO(4)	4.35	3.64	2.42	4.56	3.25	3.94	4.04	4.56	3.94
CO_2(4)	17.95	17.95	18.36	17.55	18.36	17.95	17.95	17.55	18.36
N_2	77.5	78.21	79.02	77.69	78.19	77.91	77.86	77.69	77.50
H_2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

(1)
(2) Determined by weigh scale measurements
(3) Determined by orifice flow meter measurements
(4) Density indicated by pressure tap readings
Determined by continuous analyzer

Table 30-1. REGENERATOR DATA FOR RUN 30 (Sheet 2 of 8)

	Balance Period No. 2								
	12/3								
Date Time	0800	1000	1200	1400	1600	1800	2000	2200	2400
Preheat Temperatures									
Acceptor Lift, °F	940	940	940	940	940	940	940	940	940
Air and Recycle, °F	835	830	830	830	835	830	830	830	840
Char Lift, °F	750	750	750	750	750	750	750	750	750
Char Feed, Average Rate, lb/hr(1)	388	388	388	388	388	388	388	388	388
Ash Lockhopper, Average Rate, lb/hr(1)	77.95	77.95	77.95	77.95	77.95	71.95	71.95	71.95	77.85
Gas Flows(2)									
Acceptor Lift, SCFH	58,500	58,900	59,000	58,300	58,400	58,500	58,500	58,300	58,500
Char Lift, SCFH	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Air Line									
Recycle, SCFH	40,200	40,100	40,200	40,000	40,100	40,200	40,200	40,000	40,200
Air, SCFH	37,500	37,500	38,300	38,300	38,600	38,500	39,600	38,600	39,700
Purges									
Recycle, SCFH	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
Elliott Test Fixture, SCFH	8,600	9,000	8,900	8,800	9,700	9,400	9,000	9,000	8,500
Vent Rate, SCFH	30,900	31,600	31,000	29,300	29,200	32,700	32,700	32,600	29,300
Total Flow Out, SCFH	39,500	40,600	39,900	38,100	38,900	42,100	41,700	41,600	37,800
Bed Conditions									
Gas Velocity Inlet, ft/sec	2.73	2.74	2.76	2.74	2.76	2.75	2.78	2.76	2.78
Bed Density, lb/ft^3(3)	109	109	109	107	107	107	107	107	107
Average Bed Temperature, °F	1843	1844	1848	1848	1854	1844	1851	1861	1853
Overhead Gas Analyses, Mol %									
CO(4)	4.04	4.04	3.06	4.35	2.96	4.04	4.04	3.54	3.64
CO_2(4)	17.95	17.95	18.36	17.95	17.95	17.95	17.95	18.36	18.35
N_2	77.81	77.81	78.38	77.5	78.88	77.81	77.81	77.90	77.80
H_2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

(1) Determined by weigh scale measurements
(2) Determined by orifice flow meter measurements
(3) Density indicated by pressure tap readings
(4) Determined by continuous analyzer

Table 30-1. REGENERATOR DATA FOR RUN 30 (Sheet 3 of 8)

	Balance Period No. 2							
Date	12/4							
Time	0200	0400	0600	0800	1000	1200	1400	1600
Preheat Temperatures								
Acceptor Lift, °F	935	935	940	940	940	940	940	920
Air and Recycle, °F	830	835	830	835	835	835	830	830
Char Lift, °F	750	740	730	750	750	755	750	750
Char, Feed, Average Rate, lb/hr(1)	388	388	388	388	388	388	388	388
Ash Lockhopper, Average Rate, lb/hr(1)	77.85	77.85	77.85	77.85	79.2	79.2	79.2	79.2
Gas Flows(2)								
Acceptor Lift, SCFH	58,300	58,400	58,400	58,400	58,400	58,500	58,100	58,000
Char Lift, SCFH	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Air Line								
Recycle, SCFH	40,000	40,100	40,100	40,100	40,100	40,200	39,900	39,800
Air, SCFH	38,800	38,800	38,900	38,700	38,700	38,600	39,200	39,600
Purges								
Recycle, SCFH	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
Elliott Test Fixture, SCFH	8,100	7,700	7,700	8,900	9,000	8,900	8,900	9,300
Vent Rate, SCFH	30,900	29,300	32,200	28,100	28,100	33,000	30,800	32,300
Total Flow Out, SCFH	39,000	37,000	39,900	37,000	37,100	41,900	39,700	41,600
Bed Conditions								
Gas Velocity Inlet, ft/sec	2.77	2.77	2.76	2.76	2.75	2.76	2.76	2.77
Bed Density, lb/ft^3(3)	107	107	107	107	107	107	107	105
Average Bed Temperature, °F	1860	1857	1852	1856	1844	1850	1852	1853
Overhead Gas Analyses, Mol %								
CO(4)	2.97	2.78	3.44	2.69	3.84	3.06	2.15	3.35
CO_2(4)	18.36	18.76	18.76	18.76	18.15	18.36	18.56	17.95
N_2	78.47	78.26	77.50	78.35	77.81	78.38	79.09	78.5
H_2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

(1)
(2) Determined by weigh scale measurements
(3) Determined by orifice flow meter measurements
(4) Density indicated by pressure tap readings
Determined by continuous analyzer

Table 30-1. REGENERATOR DATA FOR RUN 30 (Sheet 4 of 8)

	Balance Period No. 2							
	12/4				12/5			
Date Time	1800	2000	2200	2400	0200	0400	0600	0800
Preheat Temperatures								
Acceptor Lift, °F	920	920	920	915	915	920	920	920
Air and Recycle, °F	830	830	830	830	830	825	830	835
Char Lift, °F	750	750	750	750	750	750	745	745
Char Feed, Average Rate, lb/hr(1)	388	388	388	388	388	388	388	388
Ash Lockhopper, Average Rate, lb/hr(1)	88.5	88.5	88.5	88.5	76.9	76.9	76.9	76.9
Gas Flows(2)								
Acceptor Lift, SCFH	58,500	58,500	58,400	58,300	58,000	58,000	58,200	58,300
Char Lift, SCFH	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Air Line								
Recycle, SCFH	40,200	40,200	40,100	40,100	39,800	39,900	40,000	39,500
Air, SCFH	39,900	40,100	39,900	39,200	39,100	37,700	39,900	38,100
Purges								
Recycle, SCFH	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
Elliott Test Fixture, SCFH	9,300	9,300	9,400	8,900	8,900	8,900	8,100	7,700
Vent Rate, SCFH	31,000	33,000	29,500	30,100	30,000	29,400	30,900	29,500
Total Flow Out, SCFH	40,300	42,300	38,900	39,000	38,900	38,300	39,000	37,200
Bed Conditions								
Gas Velocity Inlet, ft/sec	2.79	2.79	2.78	2.78	2.75	2.72	2.78	2.74
Bed Density, lb/ft^3(3)	105	105	105	107	107	104	104	104
Average Bed Temperature, °F	1853	1854	1850	1862	1846	1842	1854	1858
Overhead Gas Analyses, Mol %								
CO(4)	3.84	3.54	3.74	1.72	3.06	2.97	2.78	2.78
CO_2(4)	17.95	17.95	17.95	18.76	18.76	18.36	18.76	19.58
N_2	78.01	78.31	78.11	79.32	77.98	78.47	78.36	77.54
H_2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1

(1) Determined by weigh scale measurements
(2) Determined by orifice flow meter measurements
(3) Density indicated by pressure tap readings
(4) Determined by continuous analyzer

Table 30-1. REGENERATOR DATA FOR RUN 30 (Sheet 5 of 8)

	Balance Period No. 3						
Date	12/5						
Time	1200	1400	1600	1800	2000	2200	2400
Preheat Temperatures							
Acceptor Lift, °F	555	565	540	550	560	560	560
Air and Recycle, °F	830	830	830	830	830	830	840
Char Lift, °F	750	750	750	755	755	755	740
Char Feed, Average Rate, lb/hr(1)	428	428	428	428	428	428	428
Ash Lockhopper, Average Rate, lb/hr(1)	101.6	101.6	101.6	126.6	126.6	126.6	126.6
Gas Flows(2)							
Acceptor Lift, SCFH	76,100	76,200	76,100	76,400	76,200	76,200	77,200
Char Lift, SCFH	8,500	8,400	8,400	8,500	8,500	8,500	8,500
Air Line							
Recycle, SCFH	28,600	28,600	18,400	18,500	18,400	18,400	19,400
Air, SCFH	44,400	44,100	45,100	45,000	46,000	44,700	45,400
Purges							
Recycle, SCFH	1,100	1,100	1,100	1,100	1,100	1,100	1,100
Elliott Test Fixture, SCFH	8,100	8,900	8,500	8,900	8,800	8,800	8,500
Vent Rate, SCFH	39,200	37,300	34,500	35,700	36,700	36,400	35,000
Total Flow Out, SCFH	47,300	46,200	43,000	44,600	45,500	45,200	43,500
Bed Conditions							
Gas Velocity Inlet, ft/sec	3.02	2.99	2.81	2.82	2.85	2.81	2.86
Bed Density, lb/ft^3(3)	104	104	104	103	103	103	100
Average Bed Temperature, °F	1862	1848	1842	1842	1855	1846	1845
Overhead Gas Analyses, Mol %							
CO(4)	2.87	3.06	1.98	3.74	1.72	2.15	2.15
CO_2(4)	19.58	19.58	19.99	19.17	19.99	19.99	19.78
N_2	77.35	77.16	77.83	76.89	78.09	77.66	77.87
H_2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

(1) Determined by weigh scale measurements
(2) Determined by orifice flow meter measurements
(3) Density indicated by pressure tap readings
(4) Determined by continuous analyzer

Table 30-1. REGENERATOR DATA FOR RUN 30 (Sheet 6 of 8)

	Balance Period No. 3							
	12/6							
Date								
Time	0200	0400	0600	0800	1000	1200	1400	1600
Preheat Temperatures								
Acceptor Lift, °F	560	560	550	540	540	550	560	560
Air and Recycle, °F	840	835	840	835	830	825	830	830
Char Lift, °F	750	750	745	750	750	750	750	750
Char Feed, Average Rate, lb/hr(1)	428	428	428	428	428	428	428	428
Ash Lockhopper, Average Rate, lb/hr(1)	118.6	118.6	118.6	118.6	122.9	122.9	122.9	122.9
Gas Flows(2)								
Acceptor Lift, SCFH	77,100	77,300	77,200	77,700	77,600	77,100	77,400	77,000
Char Lift, SCFH	8,500	8,500	8,500	8,500	8,400	8,400	8,100	8,300
Air Line								
Recycle, SCFH	19,400	19,400	19,400	19,400	19,400	19,300	19,300	19,300
Air, SCFH	45,800	44,700	40,200	46,100	46,200	45,200	46,400	46,900
Purges								
Recycle, SCFH	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
Elliott Test Fixture, SCFH	7,200	7,200	8,100	8,900	8,900	7,200	7,300	8,800
Vent Rate, SCFH	37,600	35,800	36,100	36,100	36,800	35,300	36,900	38,300
Total Flow Out, SCFH	44,800	43,000	44,200	45,000	45,700	42,500	44,200	47,100
Bed Conditions								
Gas Velocity Inlet, ft/sec	2.88	2.83	2.82	2.88	2.88	2.85	2.85	2.90
Bed Density, lb/ft3(3)	101	100	98	95	95	94	92	92
Average Bed Temperature, °F	1853	1831	1832	1840	1839	1845	1829	1861
Overhead Gas Analyses, Mol %								
CO(4)	1.64	2.33	1.89	3.06	2.33	1.64	2.60	3.54
CO_2(4)	20.40	19.99	20.19	19.99	19.99	20.19	19.99	18.76
N_2	77.76	77.48	77.82	76.85	77.58	78.07	77.31	77.6
H_2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1

(1) Determined by weigh scale measurements
(2) Determined by orifice flow meter measurements
(3) Density indicated by pressure tap readings
(4) Determined by continuous analyzer

Table 30-1. REGENERATOR DATA FOR RUN 30 (Sheet 7 of 8)

	Balance Period No. 3							
Date	12/6				12/7			
Time	1800	2000	2200	2400	0200	0400	0600	0800
Preheat Temperatures								
Acceptor Lift, °F	555	545	545	545	550	550	550	550
Air and Recycle, °F	830	830	830	830	830	830	835	830
Char Lift, °F	750	750	750	750	750	750	750	755
Char Feed, Average Rate, lb/hr(1)	428	428	428	428	428	428	428	428
Ash Lockhopper, Average Rate, lb/hr(1)	80.4	80.4	80.4	80.4	87.9	87.9	87.9	87.9
Gas Flows(2)								
Acceptor Lift, SCFH	77,100	77,500	74,500	77,300	77,300	77,400	77,100	77,100
Char Lift, SCFH	8,300	8,300	8,400	8,400	8,400	8,400	8,400	8,400
Air Line								
Recycle, SCFH	19,300	19,400	19,400	17,400	18,400	17,400	17,400	17,400
Air, SCFH	46,100	46,800	46,000	46,200	45,700	45,100	45,500	44,900
Purges								
Recycle, SCFH	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
Elliott Test Fixture, SCFH	8,500	8,500	8,500	8,100	8,500	8,500	8,400	7,200
Vent Rate, SCFH	37,600	37,100	37,800	38,000	35,800	33,500	36,800	32,300
Total Flow Out, SCFH	46,100	45,600	46,300	46,100	44,300	42,000	45,200	39,500
Bed Conditions								
Gas Velocity Inlet, ft/sec	2.85	2.91	2.82	2.84	2.85	2.80	2.84	2.82
Bed Density, lb/ft^3(3)	92	92	92	94	93	92	92	92
Average Bed Temperature, °F	1833	1858	1848	1848	1847	1832	1859	1850
Overhead Gas Analyses, Mol %								
CO(4)	2.87	3.84	3.64	2.97	1.98	3.54	2.02	1.98
CO_2(4)	19.17	19.17	19.17	19.99	19.99	19.37	20.40	20.19
N_2	77.86	76.89	76.99	76.84	77.83	76.89	77.48	77.73
H_2	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1

(1) Determined by weigh scale measurements
(2) Determined by orifice flow meter measurements
(3) Density indicated by pressure tap readings
(4) Determined by continuous analyzer

Table 30-1. REGENERATOR DATA FOR RUN 30 (Sheet 8 of 8)

Date	11/30→		← 12/1 →		← 12/2 →		← 12/3 →		← 12/4 →					← 12/5
Time	0830	2000	1028	1540	2245	1156	1740	2010	1106	1650	0000	0620	1000	1725	2215	0520
Tote Bin No.	14	27	24	7	22	20	3	8	4	29	2	10	25	30	23	11
Sample No.	12304	12312	12326	12331	12335	12349	12353	12360	12391	12394	12402	12408	12416	12418	12424	12433
			← Balance Period No. 1 →						← Balance Period No. 2 →							
Moisture, Wt %	2.74	2.87	2.75	1.87	1.65	1.06	3.07	2.06	2.05	1.63	2.26	1.61	1.92	1.47	2.26	2.81
Ultimate Analysis, Wt % (Dry Basis)																
H	2.22	2.02	2.21	2.19	1.76	2.13	2.15	2.09	2.14	2.08	2.28	2.33	2.25	2.15	2.23	2.26
C	74.45	72.70	71.91	74.69	73.03	70.86	73.00	72.28	71.93	73.22	74.31	70.43	73.39	73.40	73.27	74.25
N	0.74	0.76	0.64	0.67	0.67	0.68	0.70	0.65				0.64	0.59			0.71
(O)	8.86	10.43	10.57	8.86	10.00	11.40	10.22	10.64				9.99	8.42			10.14
S	1.54	1.75	1.67	1.38	1.56	1.90	1.38	1.50	1.64	1.52	1.52	1.86	1.96	1.34	1.77	1.54
Ash, SO_3 Free	12.19	12.34	13.00	12.21	12.98	13.03	12.55	12.84	14.11	14.66	10.72	14.75	13.93	12.76	12.55	11.10

Date	← 12/5 →			← 12/6 →				12/7
Time	1010	1620	2115	0128	0734	1400	1705	2210	0820
Tote Bin No.	27	21	22	13	20	6	14	22	3
Sample No.	12439	12442	12447	12453	12455	12463	12465	12470	12478
	← Balance Period No. 3 →								
Moisture, Wt %	2.76	1.80	1.84	1.98	2.28	2.61	1.96	2.40	2.29
Ultimate Analysis, Wt % (Dry Basis)									
H	2.25	2.29	2.16	2.22	2.16	2.32	2.11	2.10	2.07
C	74.04	70.35	73.34	73.56	73.73	71.13	73.48	73.50	70.89
N	0.63		0.64	0.66	0.69				
(O)	9.14		8.75	10.94	8.71				
S	1.71	1.61	1.59	1.65	1.56	1.60	1.62	1.93	1.82
Ash, SO_3 Free	12.23	15.09	13.52	10.97	13.15	12.51	12.56	12.44	15.45

Table 30-2. CHAR COMPOSITIONS FOR RUN 30

Date	Time Hopper Dumped	Sample No.	Hopper "A" or "B"	Tare Weight, lbs	Gross Weight, lbs	Net Weight, lbs		Elapsed Time, hrs	Rate, lb/hr
11/30	0115	12298	B	130	350	220		7.75	28.4
	0930	12306	B	130	420	290		8.25	35.2
	1750	12310	B	130	400	270		8.33	32.4
	1850	12311	A	125	210	85		25.33	3.36
12/1	0145	12320	B	120	370	250		7.92	31.6
	0945	12329	B	140	425	285		8.00	35.6
	1730	12334	B	125	450	325	↑ Balance	7.75	41.9
12/2	0150	12340	B	150	525	375	Period	8.33	45.0
	1200	12351	A	150	525	375	No. 1	41.17	9.11
	1220	12352	B	150	820	670	↓	10.5	63.8
	2030	12361	B	180	870	710	↑	8.00	88.75
	2125	12362	A	180	185	5.0		9.42	0.5
12/3	0000	12375	A	160	190	30	"Dejunking"		
	0020	12373	B	170	780	610	Period		
	0830	Not Sampled	A				↓		
	0845	Not Sampled	B						
	1645	12399	B	175	785	610	↑	8.00	76.3
	2343	12406	B	210	700	490		6.97	70.3
12/4	0751	12411	B	220	820	600	Balance	8.13	76.2
	0900	12415	A	200	240	40	Period	24.2	1.65
	1610	12423	B	200	790	590	No. 2	8.3	71.1
12/5	0000	12432	B	210	840	630	↓	7.83	80.4
	0800	12438	B	220	800	580		8.00	68.8
	0845	Not Sampled	A	210	400	190		23.75	8.0
	1600	12446	B	190	990	800		8.00	100
12/6	0000	12454	B	200	1200	1000	↑	8.00	125
	0830	12461	B	210	1210	1000		8.50	117
	0850	12462	A	280	320	40	Balance	24.33	1.6
	1600	12468	B	330	1230	900	Period	7.5	120
12/7	0000	12477	B	190	810	620	No. 3	8.0	77.5
	0828	12484	B	230	950	720	↓	8.47	85.0
	0845	12485	A	280	350	70		24.00	2.9

Table 30-3. ASH LOCKHOPPER FOR RUN 30

Date	12/1		← 12/2 →			12/3		← 12/4 →			12/5	
Time	0945	1730	0150	1200	1220	1645	2343	0751	0900	1610	0000	0800
Sample No.	12329	12334	12340	12351	12352	12399	12406	12411	12415	12423	12432	12438
F-207 A/B	B	B	B	A	B	B	B	B	A	B	B	B
Net Weight, lbs	285	325	375	375	670	610	490	600	40	590	630	550
	← Balance Period No. 1 →					← Balance Period No. 2 →						
Moisture, %	.39	0.22	0.21	0.25	0.11	0.13	0.16	0.15	0.37	0.14	0.21	0.19
Ultimate Analysis, Wt % (Dry Basis)												
H	.28	0.31	0.39	0.29	0.13	0.16	0.24	0.20	0.29	0.19	0.25	0.13
C	13.62	12.22	7.45	4.88	3.79	5.46	7.28	7.15	3.52	7.05	6.42	6.13
N	0.06	0.03	0		0.01					0	0.04	
(O)	-0.63	-0.67	-0.63	-1.79	-0.31	-1.18	-1.37	-1.41	-1.41	-1.45	-1.17	-1.55
S	1.25	1.33	1.26	3.58	0.62	2.35	2.73	2.81	2.81	2.90	2.34	3.09
Ash, SO_3 Free	85.42	86.78	91.53	93.04	95.76	93.21	91.12	91.20	94.79	91.31	92.12	92.20
C, lbs	38.8	39.7	27.9	18.3	25.4	33.3	35.7	44.3	1.4	41.6	40.4	33.7
S, lbs	3.6	4.3	4.7	13.4	4.2	14.3	13.4	17.4	1.1	17.1	14.7	17.0
Ash, lbs	243.4	282.0	343.2	348.9	641.6	568.6	446.5	565.4	37.9	538.7	580.4	507.1

Balance Period No. 1	Total, lbs	Wt %
Gross	2039.4	100
Carbon	150.1	7.36
Sulfur	30.2	1.48
Ash	1859.1	91.16

Balance Period No. 2	Total, lbs	Wt %
Gross	3570	100
Carbon	230.4	6.45
Sulfur	95.0	2.66
Ash	3244.6	90.89

Table 30-4. ASH COMPOSITIONS FOR RUN 30 (Sheet 1 of 2)

Date	12/5	← 12/6 →				← 12/7 →		
Time	1600	0000	0830	0850	1600	0000	0828	0845
Sample No.	12446	12454	12461	12462	12468	12477	12484	12485
F-207 A/B	B	B	B	A	B	B	B	A
Net Weight, lbs	800	1000	1000	40	900	620	720	70
	← Balance Period No. 3 →							
Moisture, %	0.15	0.10	0.10	0.92	0.24	0.35	0.27	0.59
Ultimate Analysis, Wt % (Dry Basis)								
H	0.22	0.13		0.24	0.18	0.19	0.25	0.31
C	5.58	5.17	5.20	1.77	5.61	7.63	6.97	2.34
N								
(O)	-1.21	-0.47	-0.95	-1.54	-0.71	-0.50	-1.24	-1.69
S	2.42	0.93	1.90	3.07	1.42	1.00	2.47	3.38
Ash, SO_3 Free	92.99	94.24	93.85	96.46	93.50	91.68	91.55	95.66
C, lbs	44.6	51.7	52.0	0.7	50.5	47.3	50.2	1.6
S, lbs	19.4	9.3	19.0	1.2	12.8	6.2	17.8	2.4
Ash, lbs	743.9	942.4	938.5	38.6	841.5	568.4	659.2	67.0

Balance Period No. 3	Total, lbs	Wt %
Gross	5186.2	100
Carbon	298.6	5.76
Sulfur	88.1	1.70
Ash	4799.5	92.54

Table 30-4. ASH COMPOSITIONS FOR RUN 30 (Sheet 2 of 2)

Date	12/1/75			12/2/75			12/2/75			
Time	1730			0150			1200			
Sample No.	12334			12340			12351			
F-207A and B	B			B			A			
	As Received	+35 Mesh	35 X 48 Mesh	As Received	+35 Mesh	35 X 48 Mesh	As Received	+35 Mesh	35 X 48 Mesh	As Received
Screen Size, Wt %										
Tyler Mesh										
+20							0.8			1.9
20 X 28							Tr			0.2
28 X 35	1.9			6.1			0.2			1.2
35 X 48	5.9			7.0			1.0			4.7
48 X 65	7.9			6.5			1.0			5.6
65 X 100	10.4			9.2			1.4			11.4
100 X 200	19.3			12.4			4.0			31.6
-200	54.6			58.8			91.6			43.5
Elemental Analysis, Wt %										
SiO_2		35.65	76.72		29.78	75.28		18.74	73.55	
SO_3		0.47	0.93		0.72	0.87		2.20	0.98	
Na_2O		1.66	2.27		1.78	2.17		0.94	2.63	
CaO		36.14	11.77		39.77	12.17		45.21	13.32	
MgO		20.49	2.09		22.55	2.40		26.51	2.55	
Al_2O_3		4.46	5.57		4.03	5.57		4.20	5.40	
Fe_2O_3		1.69	1.60		1.52	1.55		1.46	1.68	

Table 30-5. ASH SIZE DISTRIBUTION AND ELEMENTAL ANALYSIS FOR RUN 30 (Sheet 1 of 4)

Date	12/2/75			12/3/75			12/3/75		
Time	1220			1645			2343		
Sample No.	12353			12399			12406		
F-207A and B	B			B			B		
	+35 Mesh	35 X 48 Mesh	As Received	+35 Mesh	35 X 48 Mesh	As Received	+35 Mesh	35 X 48 Mesh	As Received
Screen Size, Wt %									
Tyler Mesh									
+20						1.0			2.8
20 X 28			0.9			0.1			0.1
28 X 35			Tr			0.3			0.4
35 X 48			3.7			3.0			4.1
48 X 65			7.2			6.3			8.5
65 X 100			10.8			9.5			10.9
100 X 200			21.3			21.0			22.2
-200			56.0			58.8			51.1
Elemental Analysis, Wt %									
SiO_2	28.06	73.58		26.29	65.43		11.10	66.80	
SO_3	1.13	1.77		1.76	2.69		1.49	3.10	
Na_2O	1.69	2.29		1.38	2.84		0.44	2.28	
CaO	40.64	14.06		39.39	15.03		49.48	14.50	
MgO	23.08	2.93		25.54	4.84		33.51	4.60	
Al_2O_3	3.92	5.34		3.77	7.39		2.06	7.00	
Fe_2O_3	1.88	1.64		1.79	2.69		1.75	2.52	

Table 30-5. ASH SIZE DISTRIBUTION AND ELEMENTAL ANALYSIS FOR RUN 30 (Sheet 2 of 4)

Date	12/4/75			12/5/75			12/5/75		
Time	1610			0000			0800		
Sample No.	12423			12432			12438		
F-207A and B	B			B			B		
	+35 Mesh	35 X 48 Mesh	As Received	+35 Mesh	35 X 48 Mesh	As Received	+35 Mesh	35 X 48 Mesh	As Received
Screen Size, Wt %									
Tyler Mesh									
+20			2.4			1.2			
20 X 28			0.1			0.1			0.6
28 X 35			0.3			0.2			0.2
35 X 48			3.6			2.1			2.1
48 X 65			7.2			4.8			5.7
65 X 100			11.5			8.3			9.5
100 X 200			27.7			21.0			20.0
-200			47.3			62.3			61.7
Elemental Analysis, Wt %									
SiO_2	10.75	67.35		17.46	68.47		15.04	59.79	
SO_3	1.68	2.71		1.78	2.22		1.65	2.97	
Na_2O	0.64	2.00		1.02	1.15		0.67	2.24	
CaO	48.89	14.34		44.40	12.96		44.79	18.91	
MgO	34.15	4.88		30.70	4.89		32.38	6.72	
Al_2O_3	3.05	6.25		3.28	6.69		2.97	6.83	
Fe_2O_3	2.00	2.78		2.11	3.58		2.13	2.24	

Table 30-5. ASH SIZE DISTRIBUTION AND ELEMENTAL ANALYSIS FOR RUN 30 (Sheet 3 of 4)

Date	12/6/75			12/6/75	12/6/75		12/7/75		12/7/75	
Time	0000			0800	1600		0000		0828	
Sample No.	12454			12461	12468		12477		12484	
F-207A and B	B			B	B		B		B	
	+35 Mesh	35 X 48 Mesh	As Received	35 X 48 Mesh	As Received	35 X 48 Mesh	As Received	35 X 48 Mesh	As Received	35 X 48 Mesh
Screen Size, Wt %										
Tyler Mesh										
+20			0.1		0.3		0.2		0.1	
20 X 28			Tr		0		Tr		Tr	
28 X 35			Tr		0.1		0.1		0.1	
35 X 48			1.3		1.9		2.2		1.4	
48 X 65			3.8		5.0		5.8		3.3	
65 X 100			5.9		7.1		7.7		5.4	
100 X 200			15.8		17.3		16.8		13.7	
-200			73.1		68.4		67.2		76.0	
Elemental Analysis, Wt %										
SiO_2	13.51	57.46		46.84		52.89		67.04		63.10
SO_3	1.69	3.63		4.78		4.07		2.42		2.50
Na_2O	0.45	1.68		1.19		3.13		2.42		3.10
CaO	47.71	17.13		19.55		18.56		11.93		15.42
MgO	31.41	7.76		14.78		7.27		6.40		5.60
Al_2O_3	3.16	8.39		6.17		8.63		7.25		8.26
Fe_2O_3	2.04	4.27		6.24		5.24				2.19

Table 30-5. ASH SIZE DISTRIBUTION AND ELEMENTAL ANALYSIS FOR RUN 30 (Sheet 4 of 4)

	Balance Period No. 1	Balance Period No. 2	Balance Period No. 3
INPUT			
Char Feed, lb/hr	325	388	428
Temperature, °F	97	98	79
Moisture, %	2.16	2.16	2.16
Char Composition, Wt % (Dry Basis)			
H	2.18	2.18	2.18
C	73.27	73.27	73.27
N	0.67	0.67	0.67
(O)	9.20	9.20	9.20
S	1.66	1.66	1.66
Ash, SO_3 Free	13.02	13.02	13.02
Gas Flows			
Acceptor Lift, SCFH	55,900	58,400	77,100
Temperature, °F	1395	1050	600
Char Lift, SCFH	7,600	8,000	8,400
Temperature, °F	750	750	750
Recycle to Ring, SCFH	40,200	40,000	18,900
Temperature °F	830	830	830
Air to Ring, SCFH	32 800	39,200	46,000
Temperature, °F	830	830	830
Purges, SCFH	1,100	1,100	1,100
Temperature °F	60	60	60
Average Bed Temperature, °F	1863	1852	1842
Moisture			
Air to Regenerator, %	0.281	0.308	0.179
Recycle, %	0.381	0.381	0.422
Gas Temperature at Top of Lift Line, °F	1230	932	550

	Balance Period No. 1	Balance Period No. 2	Balance Period No. 3
OUTPUT			
Ash, lb/hr	72.9	75.0	107
Moisture, %	0.19	0.20	0.34
Ash Composition, Wt % (Dry Basis)			
H	0.26	0.21	0.22
C	7.36	6.45	5.76
N	0.02	0.02	0.02
S	1.48	2.66	1.70
Ash, SO_3 Free	91.16	90.89	92.54
Vent Gas, SCFH	32,900	39,500	44,900
Composition, Mol %			
CO (Time Weighted Average)	3.71	3.15	2.50
CO_2	18.13	18.22	19.72
N_2	78.06	78.53	77.68
H_2	0.1	0.1	0.1

Table 30-6. HEAT AND MATERIAL BALANCE DATA FOR RUN 30

Date	Time	Bed ΔP in H_2O	A * ΔP Total Inventory, Lbs	Accumulation Rate, Lbs/Hr
11/29/75	2000	445.50	13766	
11/30/75	0000	445.79	13775	
	0400	445.01	13751	
	0800	448.22	13850	+9.4
	1200	450.19	13911	
	1600	450.55	13922	+9.0
	2000	450.55	13922	
12/1/75	0000	458.99	14183	+32.6
	0400	458.99	14183	
	0800	461.17	14250	+8.4
	1200	459.35	14194	
	1600	465.82	14394	+18.0
	2000	469.81	14517	
12/2/75	0000	472.27	14593	+24.9
	0400	473.33	14626	
	0800	467.22	14437	-19.5
	1200	467.89	14458	
	1600	466.45	14413	-3.0
	2000	485.58	15004	
12/3/75	0000	478.08	14773	+45.0
	0400	448.86	13870	
	0800	452.88	13994	-97.4
	1200	451.08	13938	
	1600	448.20	13849	-18.1
	2000	448.20	13849	
12/4/75	0000	445.92	13779	-8.8
	0400	445.20	13757	
	0800	442.32	13667	-14.0
	1200	440.82	13621	
	1600	433.32	13390	-34.6
	2000	433.32	13390	
12/5/75	0000	433.62	13399	-1.1
	0400	430.02	13288	
	0800	428.58	13243	-19.5
	1200	427.14	13199	
	1600	421.32	13019	-28.0
	2000	406.56	12563	
12/6/75	0000	406.68	12566	-56.6
	0400	395.85	12232	
	0800	382.95	11833	-91.6
	1200	368.88	11398	
	1600	355.2	10976	-107
	2000	355.14	10974	
12/7/75	0000	363.39	11229	+31.6
	0400	355.68	10990	
	0800	350.76	10838	-48.9

TABLE 30-7. REGENERATOR INVENTORY FOR RUN 30

RUN 31

DECEMBER 9 TO DECEMBER 28, 1975

RUN 32

JANUARY 3 TO JANUARY 13, 1976

CO_2 ACCEPTOR PROCESS GASIFICATION

PILOT PLANT

RAPID CITY, SOUTH DAKOTA

1 SUMMARY

Runs 31 and 32 were batch-type runs in which the gasifier system was isolated. Air was injected into the char bed to provide the heat for the gasification reactions.

Run 31 was of sufficient length to obtain four balance periods using Husky char, preoxidized Westmoreland subbituminous, untreated Westmoreland subbituminous, and untreated Wyodak subbituminous coals. No adverse effects were observed using subbituminous feedstocks, and subsequent inspection of the gasifier showed no signs of deposits, oils, or tars. A new external cyclone on the gasifier also proved to operate reliably.

Run 32 utilized untreated Glenharold lignite as feedstock. This run failed to achieve its objectives due to temperature excursions in the gasifier transition section. Because of the difficulty in maintaining gasifier bed level and temperature, steam flow was reduced and boot recycle flow was increased. This was done to limit the gasification kinetics with the knowledge that the higher air to steam ratio could result in ash fusion around the side flow distribution ring. Evidence of ash fusion appeared approximately nineteen hours after the changes were made. The run was then discontinued.

The results of Run 32 were not conclusive in establishing the process tolerance for coals with moderately high sodium levels in the ash.

2 TEST DATA

Runs 31 and 32 data are presented graphically and/or tabularly at the end of these run reports. These figures and tables include:

Page

Figure 31-1. External Gasifier Cyclone System 144

Table 31-1. Gasifier Data for Run 31 145
Table 31-2. Gasifier Data for Run 31 (3 sheets) 146
Table 31-3. Gasifier Data for Run 31 (2 sheets) 149
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Table 31-5. Feedstock Composites for Run 31 152
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Table 31-11. Gasifier Char to Organic Pond for Run 31 158
Table 31-12. Gasifier Char to Organic Pond for Run 31 159
Table 31-13. Gasifier Char to Organic Pond for Run 31 160
Table 31-14. Gasifier Char to Organic Pond for Run 32 161
Table 31-15. Feeder Calibration Data for Run 31 162

3 SIGNIFICANT EVENTS AND OBSERVATIONS

3.1 TABULAR HISTORY OF RUNS 31 AND 32

3.1.1 Objectives

Run 31

(1) To calibrate the lignite feeders at operating conditions.

(2) To determine the operating conditions necessary to run subbituminous coals as feedstocks.

(3) To obtain data on the steam-carbon kinetics for subbituminous coal.

Run 32

To determine operating conditions and problems associated with using coals as feedstocks which have high sodium content.

3.1.2 Accomplishments

Run 31

(1) Enough data was obtained to calibrate the lignite feeder at operating conditions.

(2) Gasification was accomplished with four coal feedstocks:

- Husky char
- Preoxidized Westmoreland Sarpy Creek subbituminous coal
- Non-preoxidized Westmoreland Sarpy Creek Coal
- Non-preoxidized Wyodak subbituminous coal

(3) The run demonstrated that preoxidation was unnecessary and that raw subbituminous coals could be used as feedstocks.

Run 32

(1) The gasifier system was operated for 59 hours at process temperature with Glenharold lignite feed.

(2) The run demonstrated that Glenharold lignite might be a suitable feedstock.

3.1.3 Termination Causes

Run 31

All of the objectives of this run were accomplished and a smooth, orderly shutdown was made.

Run 32

A localized fused deposit was formed on the gasifier side flow ring distributor. The deposit completely bridged the ring and was approximately six inches thick. This was the result of raising the air to steam ratio in order to maintain the gasifier bed temperature. Because of the high rate of gasification, it was difficult to maintain gasifier bed level and gasifier temperature.

3.1.4 Mechanical Problems

Run 31

(1) Second stage rings had to be replaced and valves repaired on J-202, process air compressor.

(2) Grinding system had to be shut down to repair baghouse carriage drive and replace filter bags.

(3) The plant boiler shut down three times on low level due to a malfunction in the water level control.

Run 32

System was depressured to repair a leak in the suction line to the gasifier recycle compressors, J-201 A and B.

3.1.5 Process Problems

Run 31

There was a major buildup of hard scale in the diverging section of the venturi on the gasifier quench tower. The bottom section of the tower was clean.

Run 32

(1) A coal ash-derived deposit formed on the gasifier side flow gas distributor.

(2) The gasifier quench venturi developed a minor solids buildup in the diverging section. The bottom part of the tower contained deposit chunks up to 1-1/2 inches thick. The chunks were hard, black, and layered. Thus, the material might have dropped off of the tower walls.

3.2 CHRONOLOGY OF OPERATIONS

3.2.1 Run 31

Date	Time	Description
12/9	1445	System pressure testing.
"	1750	System static pressure test.
"	1820	Completed static pressure test, leak rate = 2,700 SCFH, continuing with normal startup.
"	2130	Checking pressure drops across the process heaters and gas distributor rings.
"	2210	Completed pressure drop check.
12/10	0030	Starting refractory cure for patchwork repair done in gasifier boot.
"	2030	Completed refractory cure, bringing gasifier to operating temperature.
12/11	0800	Conducting flow tests on air to gasifier and gasifier vent.
12/12	0130	Cleared two restricted gasifier side taps (FI's 2316 and 2041).
"	1700	Tested operation of new gasifier external cyclone system.
"	2020	Recycle flow to gasifier side replaced with steam.
"	2045	Introducing steam flow to gasifier boot.
"	2100	Char fed to gasifier.
12/13	1045	Air flow introduced to gasifier side.
"	1815	Gasifier char bed established; collected data for heat material balance.
12/15	1230	Removing air flow from gasifier side and lowering feed rate to conserve char inventory.
"	1335	Started preoxidation of Westmoreland Sarpy Creek subbituminous coal.
12/16	0130	Completed preoxidation.
"	0220	Air flow to gasifier side and coal feed rate returned to previous settings.
12/17	1140	Removing air from gasifier side due to malfunction of J-202, process air compressor.
"	1145	Shut down J-202 compressor for inspection.
"	2010	Air flow to gasifier, J-202 compressor repaired.
12/18	1220	Replacing char feed to gasifier with preoxidized Westmoreland subbituminous feed.

Date	Time	Description
12/19	1300	Stopped 100 area coal grinding for repair work on baghouse carriage drive.
"	1345	Shut down 100 area for maintenance to enter baghouse and free carriage drive. Also replaced one carriage hose.
"	2045	Repair on baghouse complete, restarting 100 area.
"	2347	Replacing preoxidized Westmoreland Sarpy Creek subbituminous feed with non-preoxidized Westmoreland Sarpy Creek subbituminous feed.
12/22	0800	Shut down 100 area to inspect baghouse bags due to high pressure drop across baghouse.
"	2100	Repair of baghouse complete. Replaced filter bags and blower ring flex hoses. Restarting 100 area.
12/23	0005	Replacing non-preoxidized Westmoreland Sarpy Creek subbituminous with non-preoxidized Wyodak subbituminous.
"	1330	Momentary boiler shutdown due to low water level.
12/24	0550	Boiler shut down for a few minutes due to low water level, minor system upset.
12/25	1500	Boiler shut down due to malfunction of water level control. Normal process flows regained 20 minutes later.
12/28	1047	Completed gasifier run, preparing system for planned shutdown.

3.2.2 Run 32

1/3	0130	Pressure testing gasifier system.
"	0730	Depressuring gasifier system due to system leak on suction line to gasifier recycle compressors.
"	1400	Repressuring system, repair of suction line complete.
"	1550	Static pressure test, leak rate = 2,550 SCFH.
"	2030	Started refractory cure for patchwork repair done in the gasifier boot.
1/4	0850	Conducted pressure drop tests across the process heaters and gas distributors.
"	1530	Refractory cure complete, bringing gasifier to process temperature.
"	2330	Steam introduced to gasifier side.
"	2350	Steam introduced to gasifier boot.
1/5	0040	Char feed started to gasifier.
"	0430	Air injected into gasifier side.
"	0450	Removing air from gasifier side due to restricted gasifier vent flow through flare stack.
"	0510	Stopped char feed to gasifier. Putting system on hold for inspection of flare stack.
"	1140	Taking system off hold and continuing with the run. Steam fed to gasifier side.
"	1200	Steam fed to gasifier boot.
"	1305	Air injected into gasifier side.

Date	Time	Description
1/6	1345	Shutting plant down due to curtailment of natural gas supply.
"	2210	Depressuring system.
1/9	0945	Natural gas curtailment lifted. Repressuring system for continuation of run.
"	1350	Static pressure test, leak rate = 2,100 SCFH.
"	1930	Conducted pressure drop tests across the process heaters and gas distributors.
1/10	0200	Steam introduced to gasifier side.
"	0625	Steam introduced to gasifier boot.
"	1115	Char feed started to gasifier.
"	1730	Air injection started to gasifier side.
"	2205	Started Glenharold lignite feed to gasifier.
1/12	0120	Problems in 100 area grinding system. Putting system on temporary hold to conserve feed.
"	0737	Took system off hold and continued with run.
"	0907	Replaced gasifier transition thermocouple TE-2387.
1/13	0830	Replaced gasifier transition thermocouple TE-2387 due to high temperature indication.
"	0905	Shut down plant due to large temperature excursions on TE-2387, gasifier transition thermocouple.

4 RESULTS AND DISCUSSION

4.1 BACKGROUND

Run 31 was conducted primarily to demonstrate gasifier operation with subbituminous coal feedstocks. The run was basically conducted in four parts. First, the gasifier was filled with Husky char and air was injected to reach operating temperatures. Steady-state conditions were reached and data was gathered for heat and material balance calculations. Parts two and three were designed to determine whether or not preoxidation of subbituminous coals was necessary to prevent excessive particle swelling in the gasifier. Also studied was the coking potential and steam-carbon kinetics for subbituminous coals. The operations consisted of first feeding a 5 percent preoxidized Montana (Sarpy Creek) coal, and then feeding the raw Sarpy Creek coal. Balance periods were obtained with both feedstocks. The fourth part was the study of a raw Wyoming (Wyodak) subbituminous coal as feedstock.

Run 31 demonstrated that preoxidation of subbituminous coals was probably unnecessary and that raw coal could be used as gasifier feedstocks. There was no evidence of particle swelling or coking of the raw coals. Also, no tars or oils were found in the product gas. Subsequent inspection of the gasifier revealed no deposits.

Run 32 was designed to uncover any special problems that could arise from gasifying coals with high ash sodium contents. Untreated Glenharold lignite was the feedstock for this run. Air was injected into the gasifier to supply heat for the gasification reactions. Because of the apparent high rate of gasification, it was difficult to maintain gasifier bed level and gasifier temperature. To inhibit the kinetics and raise the bed temperature, the side flow steam rate was reduced and the boot recycle gas rate was increased. The reduction of the steam flow presented some risk of causing ash slagging conditions near the gasifier side flow gas distributor. This had been shown by the results of Run 15 when the gasifier was operated in a similar manner. Approximately nineteen hours after the changes were made, a temperature of 1960°F occurred in the gasifier transition section. This indicated that a deposit had formed and the run was terminated.

4.2 ACCOMPLISHMENTS

4.2.1 Major Operational Achievements

Run 31 fulfilled all intended objectives and was terminated with a smooth, orderly shutdown.

Because of a premature shutdown, Run 32 was not fully successful. However, due to the lack of any deposits other than the transition section deposit, the results indicate that the process is tolerant of coal feedstocks which contain moderately high sodium levels in the ash.

4.2.2 Plant Data

Tables 31-1 through 31-14 summarize the plant data for both runs. The operating conditions are shown in Tables 31-1 through 31-4. Feedstock analyses are shown in Tables 31-5 and 31-6. Effluent materials are shown in Tables 31-7 through 31-14.

4.2.3 External Gasifier Cyclone (Figure 31-1)

Prior to Run 31 an external gasifier cyclone was installed in series with the internal cyclone. Operation was basically trouble free for both runs. The solids loading in the gasifier quench tower was also substantially reduced.

4.2.4 Lignite Feeder Calibration (L-207 A and B)

One of the objectives of Run 31 was to try to obtain an accurate measurement of the coal feed rate. It is desirable to have a general equation applicable to any gasifier feedstock.

The feeder calibration was run as the first part of Run 31. The test lasted six days. The feeders were run at operating conditions for the duration of the test. Husky char was used as the feedstock and measurements were made at various RPM's. All RPM readings were taken from the instruments on the control board. The elapsed time for each lockhopper was taken as the time between alarms. Each lockhopper was switched when the low level alarm sounded.

Each tote bin represents one data point. Sixty-one points were recorded, four were rejected as extraneous and eleven points had variable RPM's. The mean feed rate was 419 (LB/HR--RPM) with a mean deviation of 21 (LB/HR--RPM) and a standard deviation of 27 (LB/HR--RPM). By using lab data for the bulk density of Husky char, the general equation is:

$$\text{Feed (LB/HR)} = 9.81 \times \text{RPM} \times \text{Bulk Density}$$

This equation is accurate with ±5 percent over the total RPM range. The data is listed in Table 31-15.

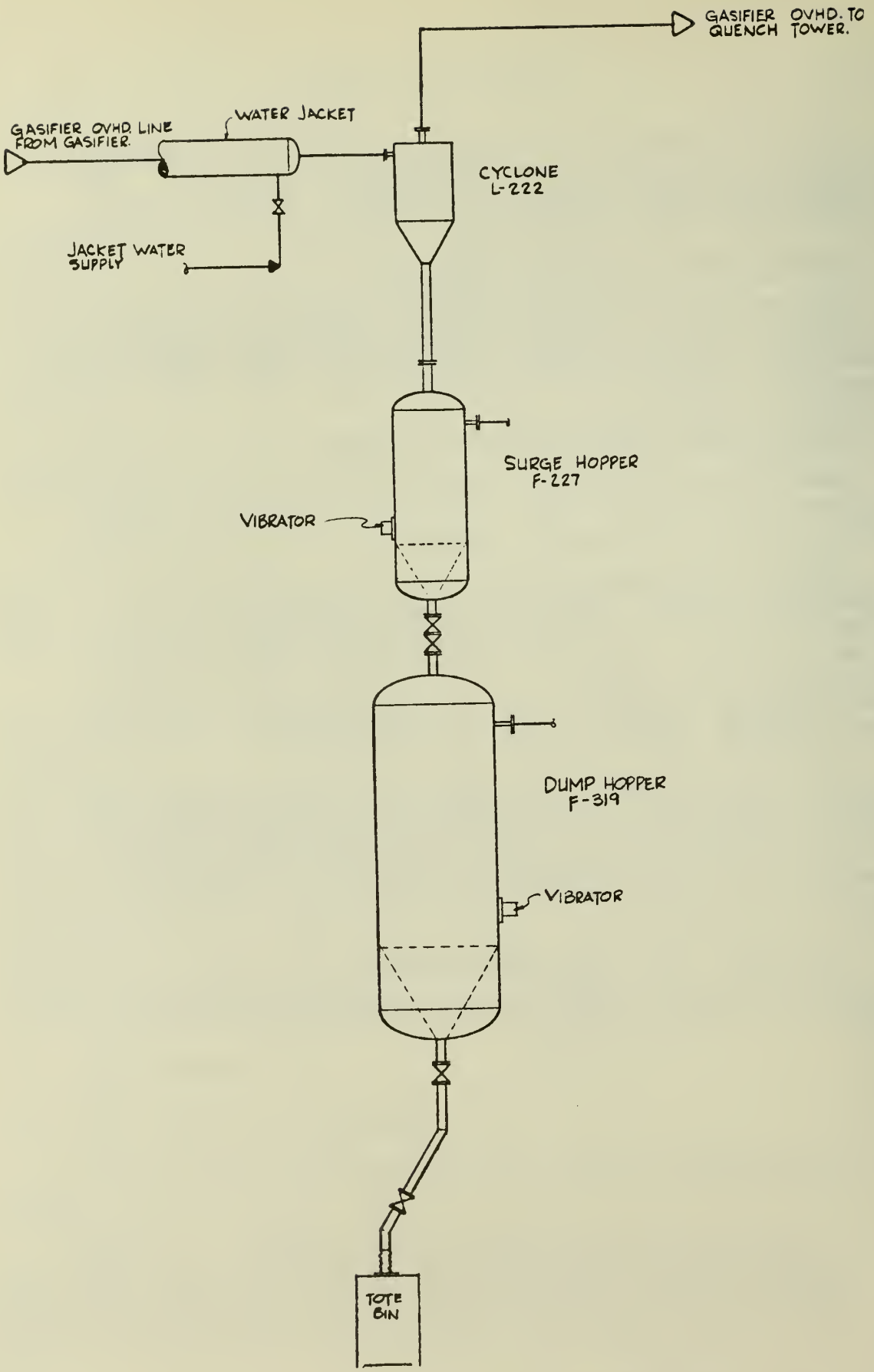

Figure 31-1. EXTERNAL GASIFIER CYCLONE SYSTEM

Date	12/14				12/15		
Time	0400	0800	1600	2400	0400	0800	1000
Jacket Steam Make, lb/hr	15	15	15	15	15	15	15
		Balance Period					
Solids							
Feedstock	Husky Char						
Feed Rate, lb/hr(1)	1,260	1,260	1,260	1,260	1,260	1,260	1,260
Char Dump (F-215), lb/hr	100	240	183	183	211		
Char Dump (F-213), lb/hr	363	413	238	312	330	495	495
Pond Solids, lb/hr	25	25	25	25	25	25	25
Cyclone Solids, lb/hr	76	76	76	75	75	75	75
Gas Flows(2)							
Boot (Recycle), SCFH	8,840	9,120	8,490	8,530	8,480	9,390	9,400
Boot (Steam), SCFH	9,210	9,210	8,160	7,090	8,210	8,160	8,150
CO_2 to Boot, SCFH	-	-	-	-	-	-	-
Steam to Side, SCFH	28,760	28,670	28,790	28,820	29,080	29,020	28,990
Air to Side, SCFH	14,450	15,700	15,600	15,810	15,610	15,400	9,490
Purges							
Recycle, SCFH	2,200	2,200	2,200	2,200	2,200	2,200	2,200
Inert, SCFH	200	200	200	200	200	200	200
Total Flow In, SCFH	63,660	65,100	63,440	62,650	63,780	64,370	58,330
Vent Rate, SCFH	19,410	33,600	30,630	34,770	36,590	33,910	9,110
Bed Conditions							
Boot Velocity, ft/sec	0.76	0.85	0.76	0.72	0.77	0.81	0.79
Char Bed Velocity, ft/sec	0.58	0.62	0.60	0.59	0.6	0.4	0.54
Boot Density, lb/ft^3(3)	26	29	27	27	27	14	14
Char Bed Density, lb/ft^3(3)	34	34	32	33	34	33	33
Boot Temperature, °F	1110	1260	1225	1255	1245	1250	1200
Char Bed Temperature, °F	1270	1340	1330	1345	1330	1340	1310
Overhead Gas Compositions, Mol %							
CO	8.3	8.3	8.4	8.2	8.2	7.6	7.6
CO_2	23	23.0	23.3	24.6	24.6	24.6	24.6
N_2	33	33.0	34.7	34.2	34.2	35.6	35.6
H_2	29.9	29.9	28.3	27.7	27.7	27.6	27.6
CH_4	5.6	5.6	5.3	5.3	5.3	5.3	5.3
C_2H_6	-	-	-	-	-	-	-
PPM H_2S	4700	4700	6200	5200	5200	1900	1900

(1) Determined by feeder RPM (9.81 X RPM X Bulk Density)
(2) Determined by orifice flow meter measurements
(3) Determined by differential pressure measurements

Table 31-1. GASIFIER DATA FOR RUN 31

Date	12/18				12/19					
Time	1200	1600	2000	2400	0400	0800	1200	1600	2000	2400
Jacket Steam Make, lb/hr	0	0	0	0	0	0	0	0	0	0
Solids										
Feedstock	Preoxidized Westmoreland Subbituminous									
Feed Rate, lb/hr(1)	980	980	1,020	1,960	1,380	1,450	1,530	1,360	1,360	1,190
Char Dump, lb/hr	240	240	200							
Cyclone Solids, lb/hr	96	96	190	190	177	96	96	170	113	113
Pond Solids, lb/hr	22	58	41	74	74	74	70	78	74	74
Gas Flows(2)										
Boot (Recycle), SCFH	6,950	7,350	8,020	8,420	8,520	8,250	8,030	7,820	7,830	7,860
Boot (Steam), SCFH	7,720	8,280	9,910	7,150	7,720	7,190	7,170	7,150	7,670	6,010
CO_2 to Boot, SCFH	-	-	-	-	-	-	-	-	-	-
Steam to Side, SCFH	29,160	32,630	32,390	32,380	32,040	32,620	31,940	31,180	29,110	27,940
Air to Side, SCFH	31,700	31,110	31,400	30,740	31,320	21,260	31,470	30,830	29,080	27,730
Purges										
Recycle, SCFH	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200
Inert, SCFH	200	200	200	200	200	200	200	200	200	200
Total Flow In, SCFH	77,930	81,770	84,120	80,990	82,000	81,720	81,010	79,380	76,090	71,940
Vent Rate, SCFH	57,580	62,970	62,010	64,190	65,660	63,990	66,820	63,900	53,642	49,470
Bed Conditions										
Boot Velocity, ft/sec	0.74	0.79	0.91	0.78	0.82	0.78	0.77	0.76	0.78	0.69
Char Bed Velocity, Inlet, ft/sec	0.81	0.85	0.88	0.83	0.85	0.85	0.84	0.82	0.78	0.73
Boot Density, lb/ft^3(3)	30	25	23	26	26	26	26	27	28	29
Char Bed Density, lb/ft^3(3)	30	25	24	25	25	24	25	26	27	27
Boot Temperature, °F	1410	1420	1420	1390	1410	1410	1410	1410	1410	1390
Char Bed Temperature, °F	1490	1510	1510	1480	1490	1500	1490	1490	1490	1460
Overhead Gas Compositions, Mol %										
CO	14.6	15.7	15.8	14.8	15.8	15.9	15.7	15.7	15.7	14.7
CO_2	19.5	16.6	17.6	18.2	17.8	17.4	17.6	17.6	17.6	18.1
N_2	35.2	36.0	36.0	33.9	34.5	34.2	34.4	34.4	34.4	34.8
H_2	27.4	28.1	27.2	27.5	27.4	27.9	27.4	27.4	27.4	26.9
CH_4	2.9	3.6	3.4	5.4	4.5	4.3	4.6	4.6	4.6	4.4

(1) Determined by feeder RPM (9.81 X RPM X Bulk Density)
(2) Determined by orifice flow meter measurements
(3) Determined by differential pressure measurements

Table 31-2. GASIFIER DATA FOR RUN 31 (Sheet 1 of 3)

Date	12/21					
Time	0400	0800	1200	1600	2000	2400
Jacket Steam Make, lb/hr	15	15	15	15	15	15
	Balance Period					
Solids						
Feedstock	Untreated Westmoreland Subbituminous					
Feed Rate, lb/hr(1)	1,490	1,490	1,490	1,490	1,490	1,490
Char Dump, lb/hr		410	247	247	247	187
Cyclone Solids, lb/hr		54	310	310	120	120
Pond Solids, lb/hr	43	30	34	40	54	67
Gas Flows(2)						
Boot (Recycle), SCFH	8,700	8,050	8,240	8,420	8,710	8,490
Boot (Steam), SCFH	6,040	6,030	6,050	6,080	6,030	6,050
CO_2 to Boot, SCFH	-	-	-	-	-	-
Steam to Side, SCFH	26,330	26,240	26,430	26,370	26,270	26,330
Air to Side, SCFH	29,820	29,680	29,480	29,510	29,730	29,870
Purges						
Recycle, SCFH	2,200	2,200	2,200	2,200	2,200	2,200
Inert, SCFH	200	200	200	200	200	200
Total Flow In, SCFH	73,290	72,400	72,600	72,780	73,140	73,140
Vent Rate, SCFH	56,720	55,250	54,700	54,280	54,940	54,530
Bed Conditions						
Boot Velocity, ft/sec	0.73	0.70	0.71	0.72	0.73	0.72
Char Bed Velocity, Inlet, ft/sec	0.75	0.73	0.74	0.74	0.74	0.74
Boot Density, lb/ft^3(3)	21	21	21	21	21	21
Char Bed Density, lb/ft^3(3)	23	22	22	22	22	21
Boot Temperature, °F	1375	1375	1375	1380	1375	1380
Char Bed Temperature, °F	1460	1460	1460	1460	1460	1460
Overhead Gas Compositions, Mol %						
CO	14.1	15.0	15.0	15.3	15.6	15.6
CO_2	16.0	16.9	16.9	17.4	17.1	17.1
N_2	35.0	36.6	36.6	36.3	36.0	36.0
H_2	29.8	26.1	26.1	26.6	26.7	26.7
CH_4	5.2	5.4	5.4	5.7	5.7	5.7
PPM H_2S	0	0	0	0	0	0

(1) Determined by feeder RPM (9.81 X RPM X Bulk Density)
(2) Determined by orifice flow meter measurements
(3) Determined by differential pressure measurements

Table 31-2. GASIFIER DATA FOR RUN 31 (Sheet 2 of 3)

Date	← 12/22 →						12/23
Time	0400	0800	1200	1600	2000	2400	0400
Jacket Steam Make, lb/hr	15	15	15	15	15	15	15
	← Balance Period →						
Solids	Untreated Westmoreland						
Feedstock	← Subbituminous →			← Untreated Westmoreland →			
Feed Rate, lb/hr(1)	1,490	1,490	1,490	1,490	1,490	1,490	1,490
Char Dump, lb/hr	159	45	45	312	178	137	137
Cyclone Solids, lb/hr	142	187	187	160	111	111	176
Pond Solids, lb/hr	55	41	47	53	57	62	49
Gas Flows(2)							
Boot (Recycle), SCFH	8,590	8,560	8,510	8,480	8,260	8,260	8,580
Boot (Steam), SCFH	6,050	5,550	5,520	8,240	7,680	7,670	7,660
CO_2 to Boot, SCFH	-	-	-	-	-	-	-
Steam to Side, SCFH	26,340	26,470	26,420	26,390	26,190	26,330	26,340
Air to Side, SCFH	29,670	29,790	29,770	29,870	29,700	29,730	29,560
Purges							
Recycle, SCFH	2,200	2,200	2,200	2,200	2,200	2,200	2,200
Inert, SCFH	200	200	200	200	200	200	200
Total Flow In, SCFH	73,050	72,770	72,620	75,380	74,230	74,390	74,540
Vent Rate, SCFH	55,680	54,620	54,750	55,330	49,320	49,370	52,480
Bed Conditions							
Boot Velocity, ft/sec	0.73	0.70	0.70	0.83	0.79	0.79	0.81
Char Bed Velocity, Inlet, ft/sec	0.74	0.74	0.74	0.77	0.76	0.76	0.76
Boot Density, lb/ft^3(3)	20	20	20	20	18	18	15
Char Bed Density, lb/ft^3(3)	21	21	21	20	20	20	20
Boot Temperature, °F	1375	1380	1380	1380	1380	1380	1380
Char Bed Temperature, °F	1465	1460	1460	1460	1460	1460	1460
Overhead Gas Compositions, Mol %							
CO	15.7	15.5	15.5	15.7	15.1	15.1	14.9
CO_2	17.0	16.4	16.4	17.2	17.6	17.6	17.0
N_2	34.8	36.3	36.3	35.5	35.9	35.9	35.5
H_2	27.0	26.4	26.4	27.0	26.6	26.6	27.0
CH_4	5.5	5.5	5.5	5.6	5.8	5.8	5.6
PPM H_2S	0	0	0	75	56	56	56

(1) Determined by feeder RPM (9.81 X RPM X Bulk Density)
(2) Determined by orifice flow meter measurements
(3) Determined by differential pressure measurements

Table 31-2. GASIFIER DATA FOR RUN 31 (Sheet 3 of 3)

Date	← 12/25 →				← 12/26 →				12/27
Time	0600	1200	1800	2400	0600	1200	1800	2400	0200
Jacket Steam Make, lb/hr	15	15	15	15	15	15	15	15	15
	← Balance Period →								
Solids									
Feedstock	← Untreated Wyodak Subbituminous →								
Feed Rate, lb/hr(1)	1,570	1,570	1,570	1,570	1,570	1,570	1,570	1,570	1,570
Char Dump, lb/hr	74	74	74	80	84	119	59	59	59
Cyclone Solids, lb/hr	124	148	148	157	156	131	153	153	144
Pond Solids, lb/hr	70	60	42	47	47	47	46	41	43
Gas Flows(2)									
Boot (Recycle), SCFH	8,610	8,570	8,560	8,690	8,970	9,080	9,030	9,130	9,010
Boot (Steam), SCFH	6,630	7,180	5,510	7,660	8,200	7,640	7,130	6,600	7,150
CO_2 to Boot, SCFH	-	-	-	-	-	-	-	-	-
Steam to Side, SCFH	26,370	26,260	26,320	26,230	26,270	26,180	26,320	26,390	26,340
Air to Side, SCFH	29,770	30,100	30,310	30,480	30,610	30,610	30,420	29,850	29,820
Purges									
Recycle, SCFH	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200
Inert, SCFH	200	200	200	200	200	200	200	200	200
Total Flow In, SCFH	73,780	74,510	73,100	75,460	76,450	75,910	75,300	74,370	74,720
Vent Rate, SCFH	57,590	59,080	59,680	60,290	61,590	59,510	60,130	60,380	59,580
Bed Conditions									
Boot Velocity, ft/sec	0.76	0.85	0.70	0.82	0.86	0.84	0.80	0.78	0.81
Char Bed Velocity, Inlet, ft/sec	0.77	0.77	0.75	0.78	0.79	0.78	0.77	0.76	0.76
Boot Density, lb/ft^3(3)	15	18	18	18	18	18	18	18	18
Char Bed Density, lb/ft^3(3)	17	20	21	21	20	21	20	20	20
Boot Temperature, °F	1400	1500	1390	1390	1390	1390	1380	1390	1390
Char Bed Temperature, °F	1500	1500	1490	1490	1480	1490	1480	1470	1470
Overhead Gas Compositions, Mol %									
CO	15.8	16.8	15.8	16.0	16.0	15.8	15.1	14.8	15.0
CO_2	16.7	16.4	16.4	16.6	16.6	16.4	16.8	16.4	16.9
N_2	34.0	34.0	35.0	37.0	36.0	35.0	35.5	34.5	35.6
H_2	27.5	27.8	27.7	27.5	27.0	26.5	26.5	27.2	27.9
CH_4	5.2	5.5	5.7	5.5	5.6	5.4	5.6	5.6	5.4
C_2H_6	-	-	-	-	-	-	-	-	-
PPM H_2S	1050	1400	1400	1250	1250	1200	1200	1450	1450

(1) Determined by feeder RPM (9.81 X RPM X Bulk Density)
(2) Determined by orifice flow meter measurements
(3) Determined by differential pressure measurements

Table 31-3. GASIFIER DATA FOR RUN 31 (Sheet 1 of 2)

Date	← 12/27 →				← 12/28 →	
Time	0600	1200	1800	2400	0400	0800
Jacket Steam Make, lb/hr	15	15	15	15	15	15
	← Balance Period →					
Solids						
Feedstock	← Wyodak →					
Feed Rate, lb/hr[1]	1,510	1,510	1,510	1,510	1,510	1,510
Char Dump, lb/hr	305	118	118	39	39	203
Cyclone Solids, lb/hr	144	148	27	27	195	195
Pond Solide, lb/hr	48	34	43	37	42	46
Gas Flows[2]						
Boot (Recycle), SCFH	8,990	9,000	8,960	9,210	9,330	9,280
Boot (Steam), SCFH	7,170	5,500	6,620	7,180	6,600	6,600
CO_2 to Boot, SCFH	-	-	-	-	-	-
Steam to Side, SCFH	26,300	26,080	26,460	26,380	26,210	26,170
Air to Side, SCFH	29,620	30,310	30,310	29,820	29,880	29,910
Purges						
Recycle, SCFH	2,200	2,200	2,200	2,200	2,200	2,200
Inert, SCFH	200	200	200	200	200	200
Total Flow In, SCFH	74,480	73,290	74,750	74,990	74,420	74,360
Vent Rate, SCFH	59,060	61,110	53,410	55,780	56,280	58,450
Bed Conditions						
Boot Velocity, ft/sec	0.81	0.72	0.78	0.82	0.80	0.79
Char Bed Velocity, Inlet, ft/sec	0.76	0.75	0.77	0.78	0.77	0.76
Boot Density, lb/ft^3[3]	18	18	18	18	18	18
Char Bed Density, lb/ft^3[3]	21	20	19	20	20	20
Boot Temperature, °F	1390	1390	1390	1390	1390	1390
Char Bed Temperature, °F	1480	1480	1480	1490	1490	1480
Overhead Gas Compositions, Mol %						
CO	15.2	15.7	15.8	15.7	15.6	15.6
CO_2	16.8	16.4	16.4	16.6	16.4	16.6
N_2	36.0	36.7	37.0	36.6	36.0	36.0
H_2	27.0	26.0	26.0	27.0	25.7	25.7
CH_4	5.3	5.2	5.8	5.3	5.2	5.3
C_2H_6	-	-	-	-	-	-
PPM H_2S	1300	980	980	800	800	900

(1) Determined by feeder RPM (9.81 X RPM X Bulk Density)
(2) Determined by orifice flow meter measurements
(3) Determined by differential pressure measurements

Table 31-3. GASIFIER DATA FOR RUN 31 (Sheet 2 of 2)

Date	1/11					1/12		1/13	
Time	1000	1400	1800	2200	2400	2000	2400	0400	0800
Solids									
Feedstock	Glenharold Lignite								
Feed Rate, lb/hr(1)	1,490	1,490	1,490	1,490	1,490	1,700	1,700	1,700	1,700
Char Dump, lb/hr	-	-	-	-	-	-	-	-	-
Cyclone Solids, lb/hr	220	68	68	41	41	73	73	136	136
Pond Solids, lb/hr	63	77	82	75	72	73	93	-	-
Gas Flows(2)									
Boot Recycle, SCFH	6,150	6,110	6,110	6,140	5,670	8,280	8,480	8,060	10,750
Boot Steam, SCFH	5,570	5,580	6,090	6,150	5,580	8,300	7,750	7,850	7,820
CO_2 to Boot, SCFH	-	-	-	-	-	-	-	-	-
Steam to Side, SCFH	26,910	27,110	26,690	27,080	26,800	22,920	23,140	23,240	22,050
Air to Side, SCFH	31,790	31,440	31,250	31,520	31,830	31,290	31,600	31,820	31,880
Purges									
Recycle, SCFH	2,730	2,730	2,730	2,730	2,730	2,730	2,730	2,730	2,730
Inert, SCFH	200	200	200	200	200	200	200	200	200
Total Flow In, SCFH	73,350	73,170	73,070	73,820	72,810	73,720	73,900	73,900	75,430
Vent Rate, SCFH	63,440	66,140	66,630	65,520	63,960	63,570	77,020	66,120	65,086
Bed Conditions									
Boot Velocity, ft/sec	0.56	0.55	0.58	0.57	0.52	0.77	0.75	0.74	0.89
Char Bed Velocity, ft/sec	0.74	0.73	0.73	0.74	0.73	0.74	0.74	0.74	0.75
Boot Density, lb/ft3(3)	18	18	15	14	14	14	12	12	12
Char Bed Density, lb/ft3(3)	20	18	16	16	16	16	17	16	16
Boot Temperature, °F	1290	1290	1300	1250	1250	1260	1250	1260	1310
Char Bed Temperature, °F	1450	1450	1450	1450	1450	1450	1450	1450	1440
Overhead Gas Compositions, Mol %									
CO	15.4	14.3	14.3	16.2	16.2	14.4	14.6	15.4	15.8
CO_2	15.4	14.8	14.8	15.4	15.4	15.2	16.0	16.8	16.8
N_2	39.3	42.8	42.8	38.4	38.4	41.0	40.4	37.9	38.0
H_2	26.0	24.3	24.3	26.2	26.2	25.5	25.0	25.3	25.0
CH_4	3.9	3.8	3.8	3.8	3.8	4.0	4.0	4.3	4.5
PPM H_2S	0	0	0	0	0	0	0	0	0

(1) Determined by feeder RPM (9.81 X RPM X Bulk Density)
(2) Determined by orifice flow meter measurements
(3) Determined by differential pressure measurements

Table 31-4. GASIFIER DATA FOR RUN 32

Screen Size, Wt % Tyler Mesh	Husky Char		Preoxidized Westmoreland Subbituminous		Untreated Westmoreland		Wyodak Subbituminous	
	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.
+6	0	0	0	0	0	0	0	0
6 X 8	0	0	0.1	0.1	0.04	0.1	0	0
8 X 10	0.5	0.5	0.4	0.3	0.2	0.1	0.3	0.2
10 X 14	5.5	2.5	3.6	0.2	4.1	0.9	4.5	0.8
14 X 20	10.1	1.9	5.8	0.5	6.7	0.7	8.0	0.7
20 X 28	16.5	0.9	10.0	1.2	11.1	1.0	12.8	1.0
28 X 35	18.7	3.7	14.4	1.5	15.48	0.6	18.4	3.1
35 X 48	19.4	2.5	21.6	0.1	20.0	0.4	21.8	1.7
48 X 65	12.2	1.2	18.0	0.5	16.2	0.6	14.9	1.7
65 X 100	7.7	0.5	12.7	1.3	12.2	1.1	10.3	1.5
100 X 200	6.2	1.5	8.3	0.6	5.5	2.8	4.9	1.6
-200	3.5	2.5	5.3	1.2	8.5	2.4	4.2	3.6
Ultimate Analysis, Wt %								
H_2O	2.44		1.17		0		0.17	
C	71.96		68.67		68.09		67.89	
H	1.93		4.16		4.81		4.71	
N	0.63		-		0.77		0.79	
S	1.73		0.69		0.69		0.73	
Ash + SO_3	12.86		8.33		6.58		6.12	

Table 31-5. FEEDSTOCK COMPOSITES FOR RUN 31

Date	1/11	1/12
Screen Size, Wt % Tyler Mesh	Glenharold Lignite	
+6		
6 X 8	0.1	0.5
8 X 10	0.3	2.0
10 X 14	13.1	11.9
14 X 20	15.5	14.5
20 X 28	15.9	16.0
28 X 35	16.0	16.0
35 X 48	14.0	15.6
48 X 65	15.3	11.4
65 X 100	7.7	8.9
100 X 200	1.7	2.6
-200	1.4	0.6
Ultimate Analysis, Wt %		
Moisture	0.45	0.75
C	66.1	65.74
H	4.27	4.05
S	0.7	0.75
Ash + SO_3	5.46	6.69
Elemental Analysis, Wt %		
SiO_2	28.4	28.15
SO_3	14.69	17.09
Na_2O	6.01	6.51
CaO	25.48	25.57
MgO	4.93	6.16
K_2O	0.81	0.62
P_2O_5	.06	0.04
Al_2O_3		9.66
Fe_2O_3		5.93
TiO_2		0.35

Table 31-6. FEEDSTOCK COMPOSITES FOR RUN 32

Date	12/14 - 15		12/18 - 19	12/21 - 23		12/25 - 28	
Time	0400 - 1000		1915 - 1930	0400 - 0400		0600 - 0800	
Screen Size, Wt % Tyler Mesh	Husky Char Avg.	Std. Dev.	Preoxidized Westmoreland Subbituminous Avg.	Untreated Westmoreland Avg.	Std. Dev.	Wyodak Subbituminous Avg.	Std. Dev.
+8	0	0	0	0	0	0	0
8 X 10	0.1	0.2	0	0.1	0.04	0.1	0.1
10 X 14	7.1	2.7	4.5	2.8	0.8	2.6	1.3
14 X 20	14.4	3.2	12.6	9.6	1.2	10.4	2.9
20 X 28	20.2	1.9	20.5	16.6	2.3	17.9	2.3
28 X 35	19.2	0.8	20.4	20.1	4.5	20.8	1.3
35 X 48	18.7	3.3	20.6	21.9	2.7	23.4	3.5
48 X 65	10.7	1.8	11.9	15.4	1.6	14.9	1.9
65 X 100	6.7	1.2	7.2	10.1	3.4	8.1	0.8
100 X 200	3.1	0.8	1.7	2.2	2.1	1.0	1.0
-200	0	0	0.5	1.2	1.5	1.0	0.9
Ultimate Analysis, Wt %							
Moisture	0		0	0.17		0.40	
C	74.01		62.97	70.36		70.50	
H	1.00		1.16	1.04		0.96	
S	0.74		0.67	0.29		0.27	
Ash + SO_3	20.97		23.21	25.17		25.32	

NOTES: One Sample

Table 31-7. PURGED CHAR COMPOSITES FOR RUN 31

Date	1/11	1/12
Screen Size, Wt %	Glenharold Lignite	
Tyler Mesh		
+8	0.2	0.7
8 X 10	0.5	3.0
10 X 14	7.4	11.4
14 X 20	16.9	16.0
20 X 28	21.9	19.7
28 X 35	18.0	19.8
35 X 48	15.0	16.5
48 X 65	11.4	7.6
65 X 100	6.4	4.1
100 X 200	2.0	0.5
-200	0.2	0.3
Ultimate Analysis, Wt %		
Moisture	0	0
C	50.7	66.1
H	0.6	0.8
S	0.9	0.51
Ash + SO_3	49.93	27.18
Elemental Analysis, Wt %		
SiO_2	43.15	44.96
SO_3	3.18	4.93
Na_2O	9.29	7.49
CaO	23.54	21.62
MgO	2.10	4.34
K_2O	0.79	0.62
P_2O_5	0.04	0.03
Al_2O_3	10.39	8.65
Fe_2O_3	7.40	7.20
TiO_2	0.16	0.27

Table 31-8. PURGED CHAR COMPOSITES FOR RUN 32

Date	12/14 - 15	12/18 - 19		12/21 - 23		12/25 - 28	
Time	0400 - 1000	1915 - 1930		0400 - 0400		0600 - 0800	
Screen Size, Wt % Tyler Mesh	Husky Char Avg.	Preoxidized Westmoreland Subbituminous Avg.	Std. Dev.	Untreated Westmoreland Avg.	Std. Dev.	Wyodak Subbituminous Avg.	Std. Dev.
+48		0.6	0.6	0.3	0.1	0.4	0.2
48 X 65	0	4.6	1.1	3.0	0.4	4.2	0.4
65 X 100	0.4	25.4	3.2	21.0	1.6	22.2	0.9
100 X 200	15.9	38.7	3.9	39.4	0.9	38.2	1.4
200 X 325	61.2	12.12	3.0	14.7	0.6	13.1	0.6
-325	22.5	14.8	2.2	20.5	2.2	21.9	1.4
Ultimate Analysis, Wt %							
Moisture	0.79	0.38		0.11		0.04	
C	63.60	61.65		61.30		64.15	
H	1.20	1.00		0.71		0.77	
S	2.13	0.54		0.59		0.47	
Ash + SO_3	26.12	30.85		35.49		32.43	
NOTES:	One Sample						

Table 31-9. GASIFIER CYCLONE CHAR FOR RUN 31

Date	1/11	1/12
Screen Size, Wt %		
Tyler Mesh		
+20		0.1
20 X 28		0.1
28 X 35		0.1
35 X 48	0.3	0.9
48 X 65	3.5	5.6
65 X 100	17.1	24.3
100 X 200	20.8	34.6
-200	58.4	34.5
Ultimate Analysis, Wt %		
Moisture	0.1	1.6
C	64.76	69.92
H	1.19	0.63
S	0.3	0.41
Ash + SO_3	28.93	22.33
Elemental Analysis, Wt %		
SiO_2	26.69	20.44
SO_3	3.39	5.14
Na_2O	6.99	9.65
CaO	34.05	36.32
MgO	7.16	6.84
K_2O	0.46	0.51
P_2O_5	0.06	0.05
Al_2O_3	12.88	12.64
Fe_2O_3	6.97	7.62
TiO_2	0.50	0.51

Table 31-10. GASIFIER CYCLONE CHAR FOR RUN 32

Date	12/14	12/14	12/15	12/15	12/14
Time	0800	1500	0000	0700	Composite
	← Husky Char →				
Screen Size, Wt %					
Tyler Mesh					
+60					1.6
60 X 100					5.1
100 X 325					21.6
-325					71.7
Ultimate Analysis, Wt %					
H_2O	-	0.4	1.20	0	0.95
C	59.03	60.41	59.57	53.38	54.69
H	1.23	1.38	1.14	1.09	2.24
S	0.79	2.22	2.38	2.11	1.97
Ash + SO_3	33.48	28.41	29.48	33.65	34.7
N					0.34
Elemental Analysis, Wt %					
SiO_2					38.9
SO_3					16.68
Na_2O					1.55
CaO					26.27
MgO					3.27
K_2O					0.23
P_2O_5					0.10
Al_2O_3					4.13
Fe_2O_3					6.69
TiO_2					1.20

Table 31-11. GASIFIER CHAR TO ORGANIC POND FOR RUN 31

Date	12/21	12/22	12/23	12/21	12/22
Time	0740	0730	0800	Composites	
	← Preoxidized Westmoreland Subbituminous →				
Screen Size, Wt %					
Tyler Mesh					
+60				6.0	14.3
60 X 100				46.8	37.7
100 X 325				25.5	31.7
-325				21.7	16.2
Ultimate Analysis, Wt %					
H_2O	0	0.15	0	0.9	0.79
C	58.44	61.73	59.95	57.23	65.28
H	1.03	2.44	0.9	0.99	1.08
S	0.91	0.84	1.18	1.19	1.28
Ash + SO_3	32.78	31.37	30.12	30.80	29.39
N				0.3	0.28
Elemental Analysis, Wt %					
SiO_2				42.64	41.79
SO_3				10.79	7.18
Na_2O				2.38	2.3
CaO				23.65	29.56
MgO				2.39	2.94
K_2O				0.76	0.15
P_2O_5				0.68	0.68
Al_2O_3				7.35	8.07
Fe_2O_3				4.07	3.35
TiO_2				1.68	1.24

Table 31-12. GASIFIER CHAR TO ORGANIC POND FOR RUN 31

Date	12/24	12/25	12/26	12/27	12/25	12/26	12/27
Time	0730	0745	0700	0745	Composites		
	Untreated Westmoreland Subbituminous			Wyodak	Un. West.		Wyodak
Screen Size, Wt %							
Tyler Mesh							
+60					1.5	1.3	0.6
60 X 100					21.4	20.7	13.4
100 X 325					42.1	16.4	15.8
-325					35.0	61.6	70.2
Ultimate Analysis, Wt %							
H_2O	0.16	0.7	0.48	0.7	2.10	0.98	1.13
C	59.88	58.95	60.69	63.24	73.21	61.57	61.17
H	1.14	0.92	0.92	0.97	1.12	0.92	1.00
S	0.81	0.99	1.08	0.96	1.04	0.68	0.76
Ash + SO_3	31.39	34.77	31.07	29.99	29.05	30.35	30.68
N					0.32	0.34	0.27
Elemental Analysis, Wt %							
SiO_2					45.47	43.71	42.23
SO_3					6.22	6.85	5.62
Na_2O					0.52	0.60	0.62
CaO					24.30	24.27	27.03
MgO					2.93	3.08	3.10
K_2O					0.16	0.09	0.07
P_2O_5					0.69	0.87	0.85
Al_2O_3					9.06	10.79	10.34
Fe_2O_3					5.21	5.82	5.98
TiO_2					1.61	1.92	1.87

Table 31-13. GASIFIER CHAR TO ORGANIC POND FOR RUN 31

Date	1/11	1/12	1/13
Time	1600	1615	0800
Screen Size, Wt %			
Tyler Mesh			
+60	0		
60 X 100	2.3	6.4	50.2
100 X 325	2.2	28.1	36.9
-325	95.5	65.6	12.9
Ultimate Analysis, Wt %			
Moisutre	26.5	0.2	
C	54.97	63.43	
H	0.72	0.48	
S	0.54	1.13	
Ash + SO_3	33.90	26.77	

Table 31-14. GASIFIER CHAR TO ORGANIC POND FOR RUN 32

No.	Date	Time	RPM	Elapsed Time, (Hrs)	Net Weight, (lbs)	lb/hr - RPM
1	12/12	2100	3.0	1.87	2400	429
2	12/13	1140	3.0	1.78	2305	432
3	"	1327	3.0	1.37	1850	451
4	"	1449	3.0	1.58	1990	419
5	"	1624	3.0	1.55	2085	448
6	"	1757	3.0	1.72	2145	416
7	"	1940	3.0	1.75	2060	393
8	"	2125	3.0	1.75	2310	440
9	"	2310	3.0	2.20	2320	352
10	12/14	0237	3.0	1.78	2280	427
11	"	0433	3.0	1.65	2180	440
12	"	0612	3.0	1.77	2220	419
13	"	0258	3.0	1.92	2220	386
14	"	0958	3.0	1.62	2240	462
15	"	1130	3.0	1.92	2130	370
16	"	1325	3.0	1.58	2230	469
17	"	1500	3.0	1.67	2240	447
18	"	1640	3.0	1.40	1940	463
19	"	1804	3.0	2.10	2305	367
20	"	2010	3.0	1.80	2310	429
21	"	2158	3.0	1.92	2350	408
22	"	2358	3.0	1.62	2000	411
23	12/15	0130	3.0	1.90	2310	405
24	"	0324	3.0	1.82	2190	401
25	"	0648	3.0	1.78	2140	401
26	12/16	0438	6.0	0.85	2050	402
27	"	0529	5.0	1.02	2100	413
28	"	0737	6.0	0.90	2200	407
29	"	0831	6.0	0.81	2245	460
30	"	0920	6.0	0.95	2375	415
31	"	1017	6.0	0.92	2200	400
34	"	2330	2.5	2.23	2340	419
35	12/17	0144	2.5	2.02	2100	416
36	"	0345	2.5	2.17	2225	411
37	"	0950	3.0	1.84	2300	417
38	"	1220	2.0	2.58	2085	404
39	"	1455	2.0	2.25	2090	463
40	"	1710	2.2	2.33	2010	392
41	"	1930	2.2	2.33	2210	431
42	12/18	0031	2.2	2.02	1980	446
43	"	0231	2.2	2.23	2085	414
44	"	0445	2.2	2.38	2215	422
45	"	0708	2.0	2.60	2150	413
46	"	0944	2.3	2.60	2280	381

Table 31-15. FEEDER CALIBRATION DATA FOR RUN 31

RUN 33

RUN 33A JANUARY 23 TO JANUARY 31, 1976

RUN 33B FEBRUARY 5 TO FEBRUARY 23, 1976

CO_2 ACCEPTOR PROCESS GASIFICATION

PILOT PLANT

RAPID CITY, SOUTH DAKOTA

1 SUMMARY

Run 33B proved technical feasibility of the CO_2 Acceptor Process using Velva lignite and limestone acceptor. The run had over seven days of steady-state operations which yielded data for heat and material balances. No uncontrollable changes in plant performance were discovered. The gasifier bed density did increase at one point but was easily brought back down by changing the auxiliary char fuel rate. No deposits which would have affected operability were found after the shutdown. A day before the shutdown was scheduled, a piece of refractory lodged in the calcined acceptor line. The early shutdown was orderly and followed the same procedure as a voluntary shutdown. No major process or mechanical problems were encountered during this run.

2 TEST DATA

Runs 33A and 33B data are presented graphically and/or tabularly at the end of this run report. These figures and tables include:

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3 SIGNIFICANT EVENTS AND OBSERVATIONS

RUN 33A

3.1 TABULAR SUMMARY

3.1.1 Objectives

The objectives of Run 33A were:

(1) To prove the technical feasibility of the process using Velva lignite.

(2) To operate the methanation unit for the production of synthetic natural gas.

3.1.2 Accomplishments

The system was at process temperatures for 67 hours of which 10 hours were without air flow to the gasifier. This performance did not accomplish any of the stated objectives.

3.1.3 Cause of Run Termination

A deposit formed in the gasifier boot when steam flow to the boot cooled to the point that $Ca(OH)_2$ formed. The boot heater had shut down and attempts to relight it had been unsuccessful for 15 minutes. Adjustments to change back to gasifier recycle gas to the boot were not made soon enough.

3.1.4 Major Modifications Made Prior to Run 33A

(1) A new reject acceptor withdrawal system was installed off of the regenerator. This system replaced the existing reject acceptor withdrawal from the gasifier boot and the char removal system which removed intermediate fines from the vessels.

(2) Ceramic cone inserts were installed in the expansion slip joints of the acceptor lift line.

(3) The sloped section of the char transfer standleg was increased from three inches to four inches in diameter.

(4) The cracked cast iron base of the roller mill in the coal grinding system was replaced with a new cast steel base.

3.1.5 Mechanical Problems

The boot heater shut down which caused the boot deposit was the only mechanical problem.

3.1.6 Process Problems

No process problems were detected during the short period of this run.

3.2 RUN HISTORY

System pressure testing started at 1535 hours Friday afternoon on January 23, 1976. During the leak test, a leak at a thermocouple on the acceptor lift line required repairs. The system was successfully pressured up by 0400 hours Saturday morning. The refractory cure for patches around the char transfer line in the gasifier started later that afternoon.

Pressure drop checks were conducted on the process heaters and gas distributors. The refractory cure was completed at 1500 hours Sunday and dead-burned dolomite was fed to the gasifier boot at 2111 hours. The solids circulation, lift line flow tests, and tests to calibrate the solids rate to the new reject acceptor withdrawal system were completed Monday afternoon and evening. Char was added to the system at 2045 hours Monday evening. Air was added to the gasifier side flow and steam to the boot. By 0900 hours Tuesday char combustion in the regenerator was started. The regenerator reached 1800^{o}F by 1040 hours. Later that evening at 1850 hours Velva lignite was fed to the gasifier.

The next day, Wednesday, January 28, fresh limestone acceptor makeup was started to the regenerator at 1800 hours. By 1900 hours Thursday all the air had been removed from the gasifier side flow. At 0500 hours the next day the gasifier boot heater shut down for some unknown reason. Within 15 minutes after the heater shut down, an upset occurred in the gasifier boot. The system was shut down later that morning, January 30.

RUN 33B

3.3 TABULAR SUMMARY

3.3.1 Objectives

The objectives of Run 33B were the same as for Run 33A:

(1) To prove the technical feasibility of the process using Velva lignite.

(2) To operate the methanation unit for the production of synthetic natural gas.

3.3.2 Accomplishments

This run accomplished all of its objectives. The run met all the major requirements for proving technical feasibility of the process. In spite of the fact that the run ended about a day before its scheduled shutdown, the shutdown proceeded in an orderly fashion and no significant deposits were found in the system. The run consisted of over seven days of steady-state operation during which the plant with the methanation unit in service produced synthetic natural gas (over 900 BTU/SCF).

3.3.3 Cause of Run Termination

The run terminated when a piece of refractory lodged in the calcined acceptor flow rate butterfly control valve. The refractory came from around the inlet of the line above the valve. The first foot or so of this line fell off into the regenerator and dislodged the refractory. Normally large chunks of any extraneous material cannot enter this line because of a grid over the inlet of the line.

3.3.4 Major Modifications Made Prior to Run 33B

The only modifications were minor instrument changes and a nozzle change on the reject acceptor hopper.

3.3.5 Mechanical Problems

The major mechanical problem during the run was caused by leaking valves below the lignite lockhoppers. This leak caused the loss of lignite feed a few times on February 21. As these leaking valves were being augmented by the addition of two new valves in the line, a major upset occurred which resulted in the loss of the char transfer. While the plant was recovering from this upset, the calcined acceptor line failed terminating the run.

3.3.6 Process Problems

There continued to be some plugging in the gasifier quench tower venturi. The plugging was most noticeable while air was being used in the gasifier. A study of the required concentration of water treatment additive used to minimize venturi deposits also led to a period where the pressure drop increased.

3.4 RUN HISTORY

System pressure testing was initiated at 1830 hours Thursday evening, February 5. Thawing of valves and lines was necessary due to the freezing weather. It was necessary to depressure the system for 2-1/2 hours Friday morning, February 6, to rotate the gasifier venturi piping. The rotation was necessary to allow proper rod-out movement.

A 13-hour refractory cure was started Friday night. The cure was needed for minor boot patchwork repair. During the cure the pressure drops across the process heaters and gas distributors were checked. All were normal.

The refractory cure was completed Saturday morning, February 7, and system heatup continued. Dead-burned dolomite was fed to the system at 1920 hours Saturday evening. Some delay in feeding was caused by a bad valve and line plugs in the feed line. A regenerator bed of dead-burned dolomite was established Sunday evening, February 8, followed by solids circulation and lift line flow tests at 1955 hours. Char feed was started to the gasifier at 2345 hours Sunday night. A char/dolomite interface was set while circulating dolomite at a low rate.

Air flow was admitted to the gasifier early Monday morning, February 9, followed by steam to the boot at 0550 hours. The gasifier char bed was established at 1215 hours Monday followed by auxiliary char feed and char transfer (from gasifier) to the regenerator. The regenerator temperature reached 1800°F at 1415 hours Monday afternoon. Char transfer was lost for 2-1/2 hours at 1540 hours for no apparent reason. Transfer was regained by char line purge adjustments and blowing into the char line. After the system was stabilized, char feed to the gasifier was replaced with lignite feed at 2257 hours Monday night.

Fresh acceptor makeup (6 X 9 mesh Minnekahta limestone) replaced dead-burned dolomite makeup at 0725 hours Tuesday morning, February 10. A small flow of carbon dioxide (about 900 SCFH) was admitted to the gasifier boot Tuesday afternoon. This was done to prevent any acceptor from calcining in the boot. Tuesday night a slip stream of gasifier synthesis gas was admitted to the CO_2 adsorber section of the methanation unit.

At 0300 hours Wednesday morning, February 11, step flow changes were initiated for removal of gasifier air and for steam adjustments.

By 0050 hours Thursday morning, February 12, all the air had been removed from the gasifier. Gasification heat was then supplied by acceptor circulation. At 1215 hours Thursday, all the recycle

gas flow was removed from the gasifier. Thursday afternoon gasifier synthesis gas was admitted to the desulfurization section of the methanation unit, followed by synthesis gas to the methanation section Thursday night.

Friday morning, February 13, all the regenerator side tap thermocouples were routinely replaced.

Char transfer from the gasifier to the regenerator was lost for 45 minutes Friday afternoon when a side flow upset occurred because of repairs which were being made on a flow controller. No problems were encountered regaining transfer. Gasification continued smoothly Saturday and Sunday, February 14 and 15. Sunday a slip stream of regenerator flue gas was started through the Elliott test stand. Gasification continued smoothly during the week. Wednesday, February 18, all the regenerator side tap thermocouples were again routinely replaced.

Char transfer was lost for 15 minutes at 1600 hours Friday, February 20. Loss of transfer was caused by a system pressure swing which resulted from a temporary loss of lignite feed. Steady-state conditions were reestablished three hours later.

Saturday afternoon, February 21, another system pressure swing occurred at 1700 hours. Lignite feed was lost due to failure of the automatic valve below F-204B, lignite lockhopper. Process gas leakage through the valve caused a loss of lignite feed from the other lockhopper, F-204A. Isolation of the valve was not possible since the manual ball valve below the automatic valve would not seal. Another manual ball valve was added above the automatic valve.

Char transfer and then acceptor circulation were lost when the ball valve was added. The gasifier interface was purposely blown with recycle gas to prevent any solids agglomeration in the gasifier boot. The gasifier interface was reestablished by adjusting the boot flow and spent acceptor transfer was restarted. Calcined acceptor transfer from the regenerator to the gasifier was regained at 2000 hours Saturday night and the run continued. Char feed to reestablish the gasifier char bed was started to the gasifier early Sunday morning, February 22. Problems were encountered reestablishing char transfer. Also, normal regenerated acceptor transfer could not be maintained during this period.

A decision to shut down the plant was made at 1330 hours after efforts to regain regenerated acceptor transfer were unsuccessful.

4 RESULTS AND DISCUSSION

4.1 PLANT OPERATIONS

During Run 33B, all of the operating and process requirements for technical feasibility were proved. A number of the process operating variables were graphically displayed to show the smoothness of the plant operation. Figure 33-1 shows the major gas flow rates. Figures 33-2 and 33-3 show the overhead gas compositions for the gasifier and regenerator. Figure 33-4 shows the acceptor activity and reactor inventories. These figures show very clearly that the plant lined out on February 14 and remained lined out until immediately preceding the shutdown. These eight days represent the best period of plant operation achieved to date. Much of the success for the run must be attributed to the successful operation of the new acceptor removal system, the new acceptor lift line cones, and the auxiliary char fuel system. The new acceptor removal system controlled the junk inventories and did not cause any system upsets. The auxiliary char fuel system provided the means for a smooth, quick startup and allowed one to control the gasifer bed level and density within certain limits while maintaining a constant lignite feed rate. Figure 33-5 shows the effect a small change in auxiliary fuel rate had upon the gasifier bed density and level. This use of the auxiliary char feed controlled what could have been a degenerate increase of bed density.

The quench system performed well as did the coal grinding systems. No section of the plant had a mechanical malfunction until the shutdown. While the shutdown was not entirely voluntary, it was smooth and orderly and it proceeded in the manner of a voluntary shutdown.

The hours of operations at various conditions also reflect the success of the run:

Hours of gasification without air flow to the gasifier	=	249
Hours of gasification without recycle flow to gasifier	=	221
Hours of methanation of gasifier synthesis gas	=	211
Hours of system pressure	=	416
Hours at process temperatures	=	291
Hours with lignite feed	=	282
Hours with active 6 X 9 limestone feed	=	271
Hours of acceptor circulation	=	332

4.2 SYSTEM PRESSURE BALANCE AND CHAR TRANSFER

The success of Run 33B reflects that there were few, if any, problems with the system pressure balance and fuel char transfer. Char transfer only became a problem when drastic system pressure swings

occurred. This happened once early in the run and twice towards the end of the run when there was a problem maintaining continuous feed from the lignite lockhoppers. None of these upsets caused an extended loss of char feed.

Pressure balance data were collected at various times during the startup and throughout the run. The data and resulting calculated pressures for the system are presented in Table 33-1 and Figure 33-6. These data reflect stable operation at various densities for both the gasifier and regenerator beds and gasifier bed heights. These data demonstrated the control of the system pressure balance during many modes of operation.

The report on Run 26 included a detailed discussion of the effects of pressure balance on the performance of the char transfer standleg. In that report a dimensionless group or pressure drop factor for a given section of a standleg was defined as:

$$\Delta P / \rho L$$

Where: ΔP = pressure drop across the line

ρ = measured density of the material in the line

L = length of the line

Since the density of the material in the line itself was not measured, the density of the gasifier char bed was used. As the pressure drop factor approached 1.0, the material in the line tends to become fluidized and restricts flow. This factor, therefore, represents the stability of the char standleg.

An extensive study of the breakdown of the pressure drop between the sloped and vertical section of the char standleg was made using the calculated pressure drop factor for Run 33. A similar study was done for Run 26. For Run 33 the char removal system was not used, and the sloped section of the standleg had been enlarged from three to four inches in diameter. An extensive study was necessary to evaluate these changes.

The pressure drop factors recorded in Table 33-2 show a remarkable uniformity not only during the course of the run but also between the sloped and vertical sections of the line. Overall, the sloped section had a slightly lower pressure drop factor than the vertical section. This seems to verify the need for a larger line size for the sloped standleg than for the vertical standleg. The data cannot be conclusive as the system was never pushed to the limit to verify whether the sloped and vertical standlegs would fail at different pressure drop factors. These data have not been obtained since acquisition would be very disruptive to an otherwise good run.

4.3 REJECT ACCEPTOR WITHDRAWAL SYSTEMS

A new system to withdraw the reject acceptor from the regenerator (F-228, see Figure 33-7) was installed prior to Run 33. The existing system (F-213) withdrew acceptor from the gasifier boot. The operation of F-213 caused numerous upsets and the termination of many runs. The pressure swings when F-213 was taken out of service for dumping or returned to service disturbed the flow patterns in the gasifier boot. Also, by removing the reject acceptor from the regenerator, enough of the intermediate fines material is also withdrawn to eliminate the need for the char withdrawal system. Figure 33-8 shows the intermediate fines inventory during Run 33B. This figure shows that the junk* level was kept well under control with just the use of the new reject acceptor system. This material does not shower through the char bed and does not collect in the gasifier boot to be withdrawn there. The intermediate fines collect in the char bed and are transferred to the regenerator with the fuel char. By eliminating the use of the char withdrawal system, the major cause of plant upsets was eliminated. Losses of char transfer resulting from the operation of the char withdrawal system never terminated a run, but these losses were very disruptive to steady-state operation. Two major sources of process upsets were eliminated by removing the reject acceptor from the regenerator instead of the gasifier boot.

4.4 ACCEPTOR LIFT LINE

Run 33 was the first run using the new ceramic cone design in the transition of the inner liner slip joints in the acceptor lift line. The ceramic liners held up quite well showing no wear by visual inspection. Further inspection of the one liner which was checked was not possible as it was dropped and broken shortly after being removed. This liner had seen 420 hours of operation. The design of these cones is shown in Figure 33-9. This design incorporates a smooth transition from the female part of the slip joint back to the original pipe size. Also, the entire transition is lined with Coors' AD 85 ceramic. The jacket which holds the ceramic is machined from 310 SST. The tolerances on the jacket are very tight to prevent movement of the ceramic. Also, an insulating layer of FIBERFRAX paper keeps the metal jacket cooler than the ceramic so that at temperature the ceramic is still held tightly. The ceramic will take a great deal of compression forces but is very susceptible to tensile fracturing. The new ceramic transition pieces worked quite well. A weld on the metal jacket had failed during the shutdown but was easily repaired after the ceramic was replaced.

4.5 GASIFIER QUENCH SYSTEM

The gasifier quench system caused no major problems during either Runs 33A or 33B. Examination of the venturi and quench tower after the run showed the usual calcium carbonate buildups; however, rod-out devices allowed clearing the venturi when necessary. The venturi throat and the tower inlet were rodded at least once per shift. After Run 33A the deposit

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* Intermediate fines material - normally 20 x 65 Tyler mesh particles of shale, clays, sandstone, and quartz which are in the coal feedstock in small quantities.

in the venturi was irregular and not quite as thick as usual. The deposit in the tower opposite the gas inlet was about one-fourth inch thick. After Run 33B the deposit in the venturi restricted flow to the two-inch diameter hole left where the rod out cleaned. The deposit in the tower was about one-inch thick.

In defense of the present additive program, a study of additive concentration probably led to these deposits. A program of reducing the concentration to establish the minimum concentration required was initiated during Run 33B. Betz DP-670 was the additive tested during both 33A and 33B. During Run 33A the concentration was maintained at 485 PPM, and there was no increase in pressure drop across the venturi. Also, air was added to the gasifier throughout 33A except for only a few hours. The period of air addition is always the worst part of the run for deposit buildup in the venturi and quench tower. For Run 33B the additive concentration was 275 PPM during air addition and 65 PPM after air was removed. Neither of these periods showed an increase in the venturi pressure drop. A third period at 40 PPM concentration showed an increase of 0.3 PSI/HR. The majority of the deposit found after Run 33B probably resulted from this last period. While the additive controls the buildup of deposits to a certain extent, it has not eliminated them. The extensive program of additive testing will continue.

4.6 METHANATION

Run 33B was the first run during which the methanation unit was operated extensively (211 hours). Figure 33-10 shows a schematic of the process flow in the methanation section. Gas from the gasifier quench tower knockout pot sequentially passes through a carbonate tower, zinc oxide reactor, the packed tube methanator with a knockout pot and to the adiabatic cleanup reactor with a knockout pot. From the methanation unit, the product gas is flared. The carbonate tower removed the bulk of the sulfur and a desired amount of the carbon dioxide from the feed gas. The zinc oxide adsorbs any sulfur not removed in the carbonate tower to protect the catalyst in the methanator. The packed tube methanator is the primary methanation reactor. Practically all the methanation takes place in the packed tube reactor. A water knockout and cleanup reactor assure that all the carbon oxides are reacted. The design of the packed tube reactor has been detailed in the Run 29 report. Basically, the reactor is a modification of a floating head exchanger with catalyst within the tubes. Gas flows down the tubes and up and out through a center outlet pipe. The tubes are cooled by circulating Dowtherm.

Some tubes have movable thermocouples to study temperature profiles through the reactor. Table 33-21 shows these profiles. Gas compositions and flow rates are recorded in Table 33-22.

Successful operation of the methanation units allowed integrated plant operation yielding 900 BTU/SCF gas. Run 33B clearly demonstrated that the packed tube methanation reactor provides a workable design for converting synthesis gas into synthetic natural gas.

4.7 PLANT DATA

Run 33A

The tables showing the plant data for Run 33A are Tables 33-3 through 33-10. Gasifier and regenerator data are in Tables 33-3 and 33-4 respectively. Feedstock compositions are in Table 33-5. Table 33-6 shows data for both of the circulated acceptor streams. The reject acceptor data and the char bed material data are in Tables 33-7 and 33-8. The gasifier char which is washed out of the product gas in the quench tower was analyzed and this data is in Table 33-9. Table 33-10 finishes the data for Run 33A with the ash and attrited acceptor data.

Run 33B

Because Run 33 was such a long run and such a steady run, the data in Tables 33-11 through 33-20 represent the best plant data available to date. Solids rates in and out of the vessels, gas flow rates, bed conditions and gas compositions are recorded for the gasifier and regenerator in Tables 33-11 and 33-12. The period from 0300 hours on February 14 to 0300 hours on February 21 represents a very stable period of operation. The rates of solids from the system to lockhoppers were averaged over this period to better represent the actual withdrawal rates. Deviations from these averages were normally minor. Any deviations which did occur probably result from holdup in the lockhopper or minor inventory changes in the reactors. Table 33-13 shows the characteristics of the startup dead-burned dolomite and Minnekahta limestone acceptor and the startup Husky char and Velva lignite feeds. Data on the circulating acceptor is in Tables 33-14 and 33-15. Table 33-14 shows the calcined acceptor to the gasifier and Table 33-15 shows the recarbonated acceptor from the gasifier. The reject acceptor is withdrawn to the new lockhopper system off the regenerator. No material was withdrawn from the old purge system off of the gasifier boot. The reject acceptor data is in Table 33-16. Table 33-17 shows data on the char bed material. The char bed sample is withdrawn directly from the gasifier char bed during the run. The char bed contains the char, acceptor, and intermediate fines. The sample is first sized and analyzed as a whole, then the char fraction burned off to leave ash, acceptor, and intermediate fines. The ash is screened out at 80 Tyler mesh and the remaining portion is sized. The fractions

larger than 20 Tyler mesh are considered acceptor and those smaller than 20 Tyler mesh are intermediate fines. The distinction between acceptor and fines is somewhat arbitrary but represents the fractions that shower freely and those that stay in the char bed. Some portion of the gasifier char exits the gasifier and is collected in the external cyclone or is washed out of the product gas in the gasifier quench tower. Data on these materials is in Tables 33-18 and 33-19. Ash and attrited acceptor are blown out of the regenerator and are collected by two external cyclones in series. Ash from the B lockhopper comes from the primary cyclone while the secondary cyclone dumps through the A lockhopper. The data on the ash and attrited acceptor is in Table 33-20.

5 FUTURE PLANS

The next run will feature the use of Glenharold lignite as feedstock. The run will be conducted in essentially the same manner as Run 33. Glenharold lignite has a much higher sodium content and is more representative of the numerous lignite deposits than is Velva lignite.

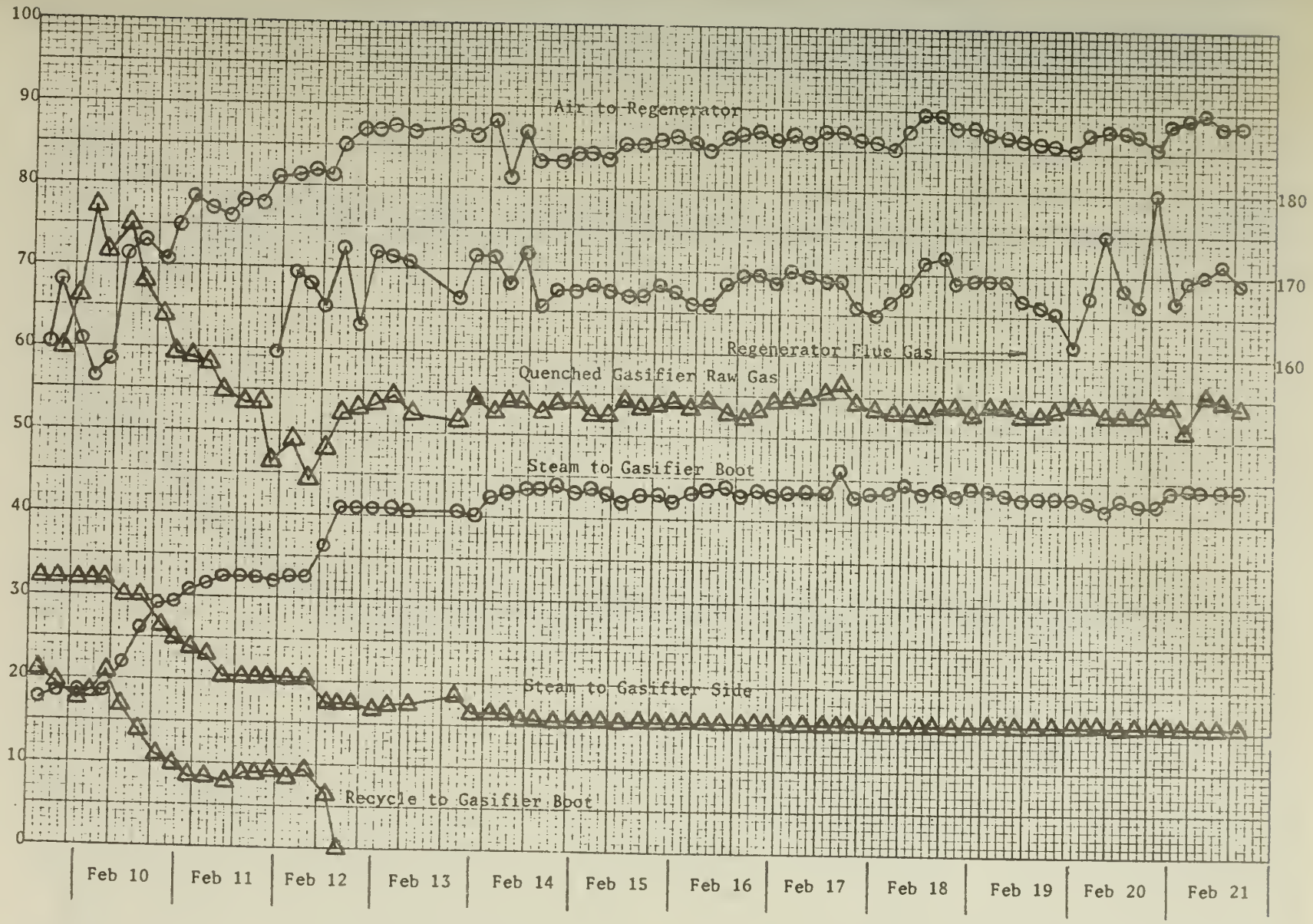


Figure 33-1. GAS FLOW RATES FOR RUN 33B

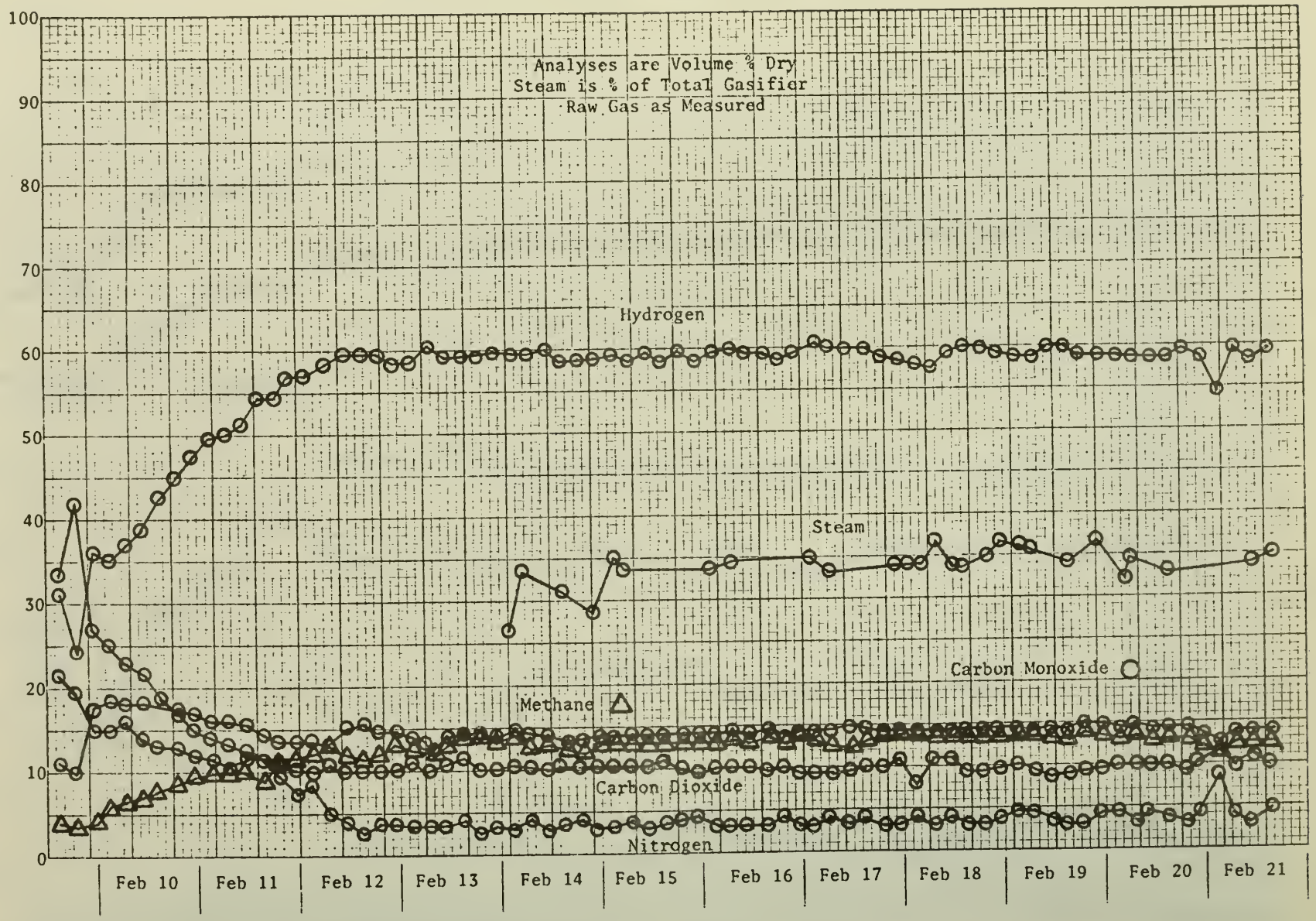


Figure 33-2. GASIFIER RAW GAS COMPOSITIONS FOR RUN 33B

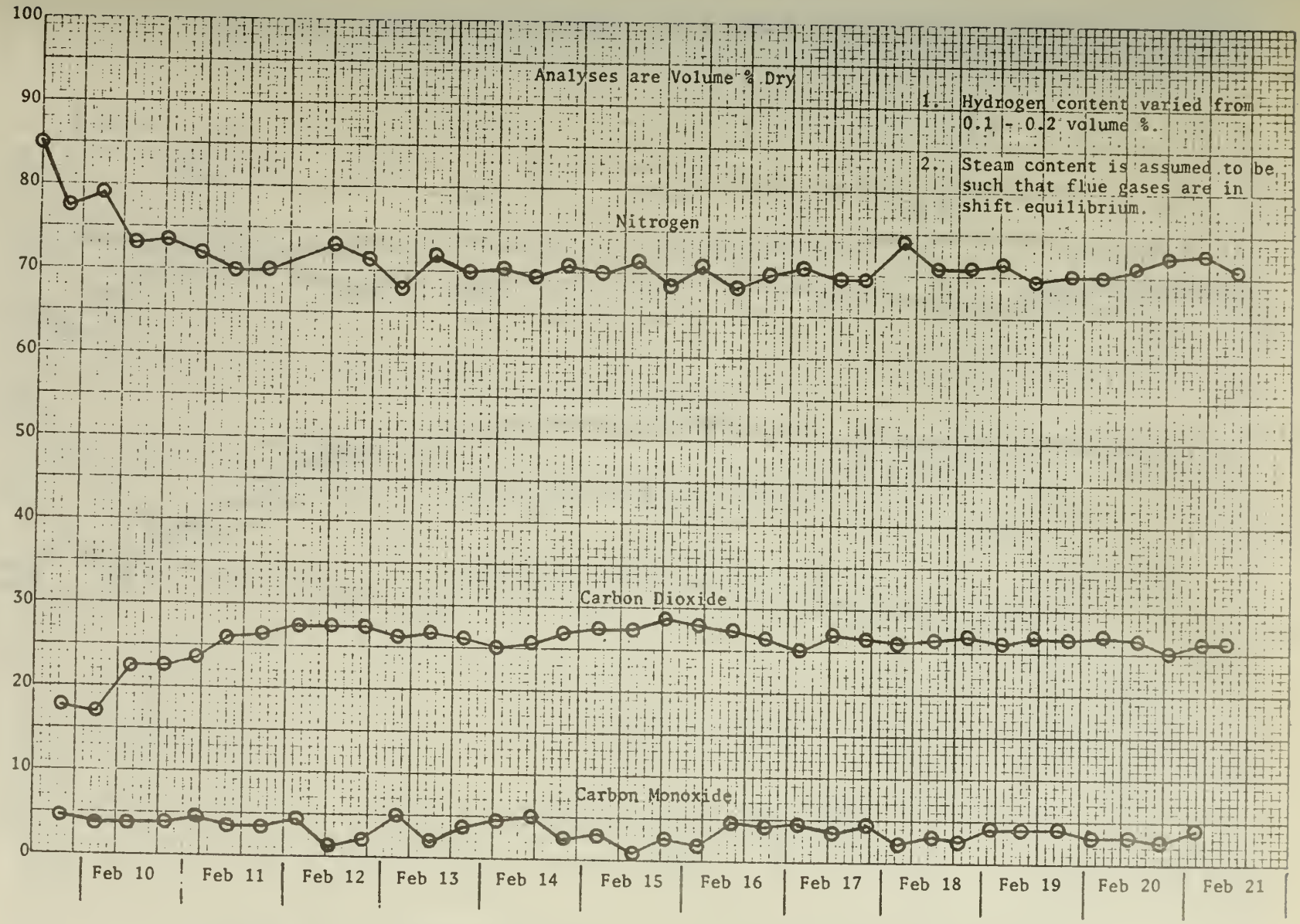


Figure 33-3. REGENERATOR FLUE GAS COMPOSITIONS FOR RUN 33B

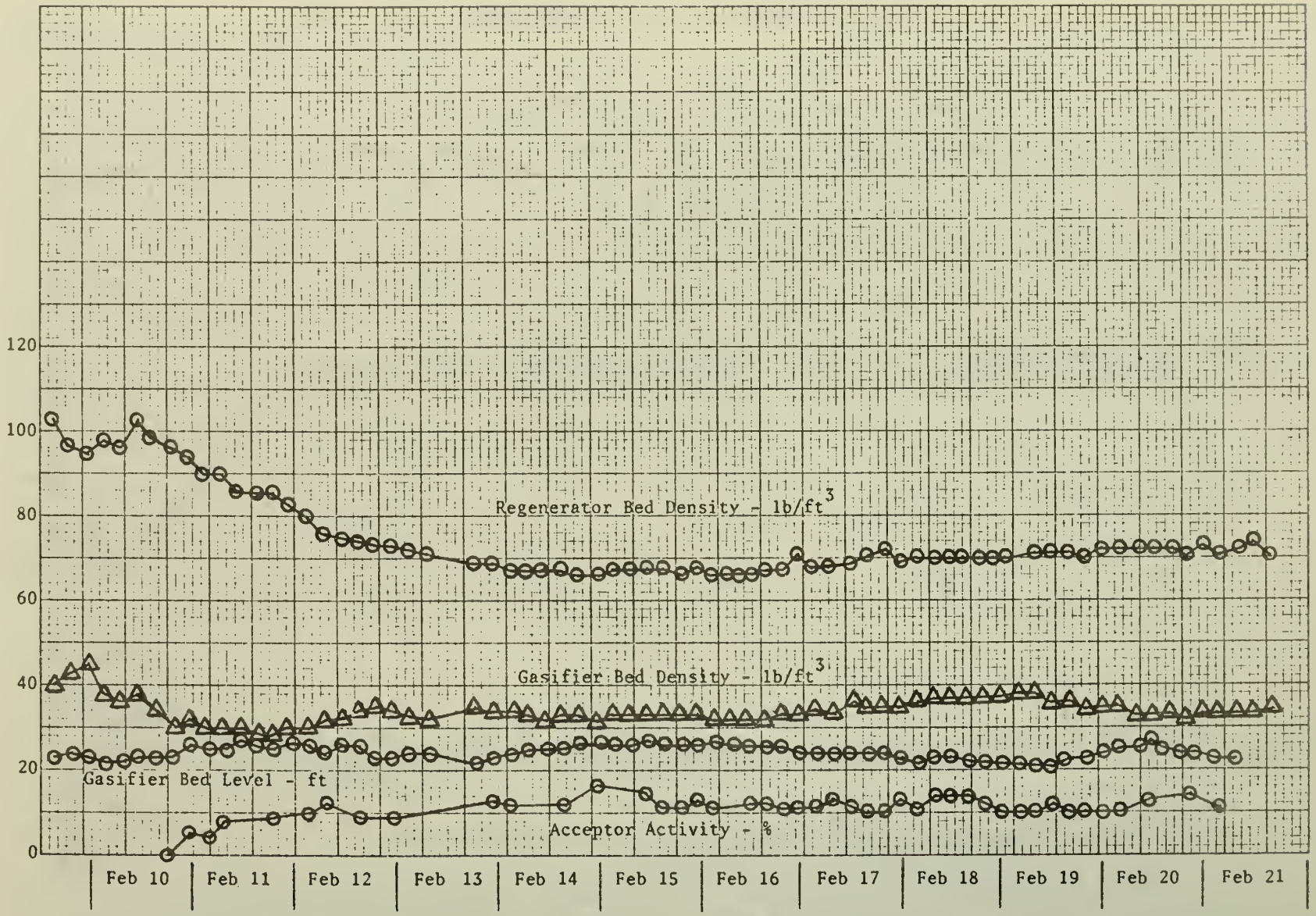


Figure 33-4. FLUID BED INVENTORIES AND ACCEPTOR ACTIVITY FOR RUN 33B

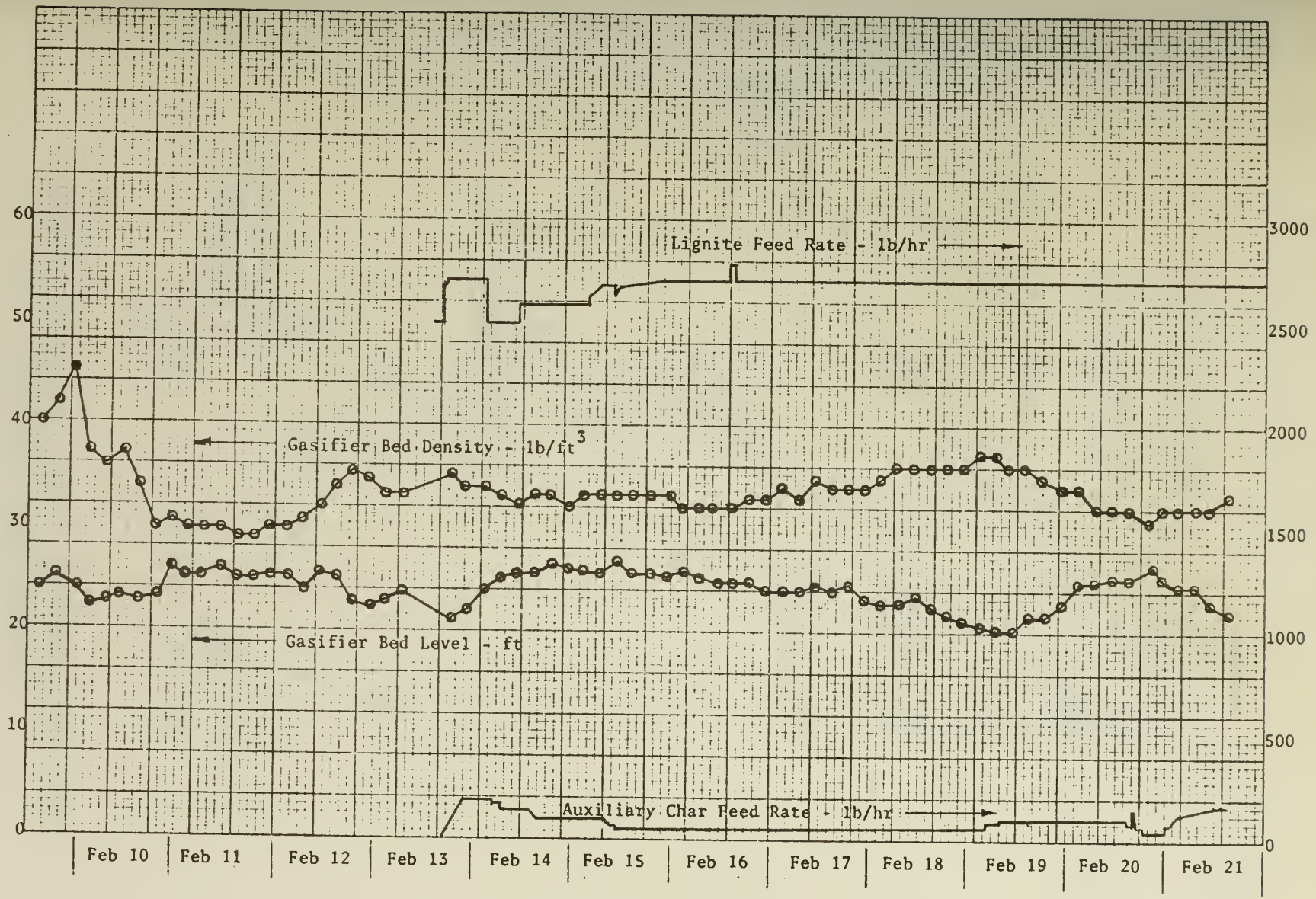


Figure 33-5. LIGNITE AND AUXILIARY CHAR FLOW RATES AND THEIR EFFECT ON GASIFIER BED LEVEL AND BED DENSITY FOR RUN 33B

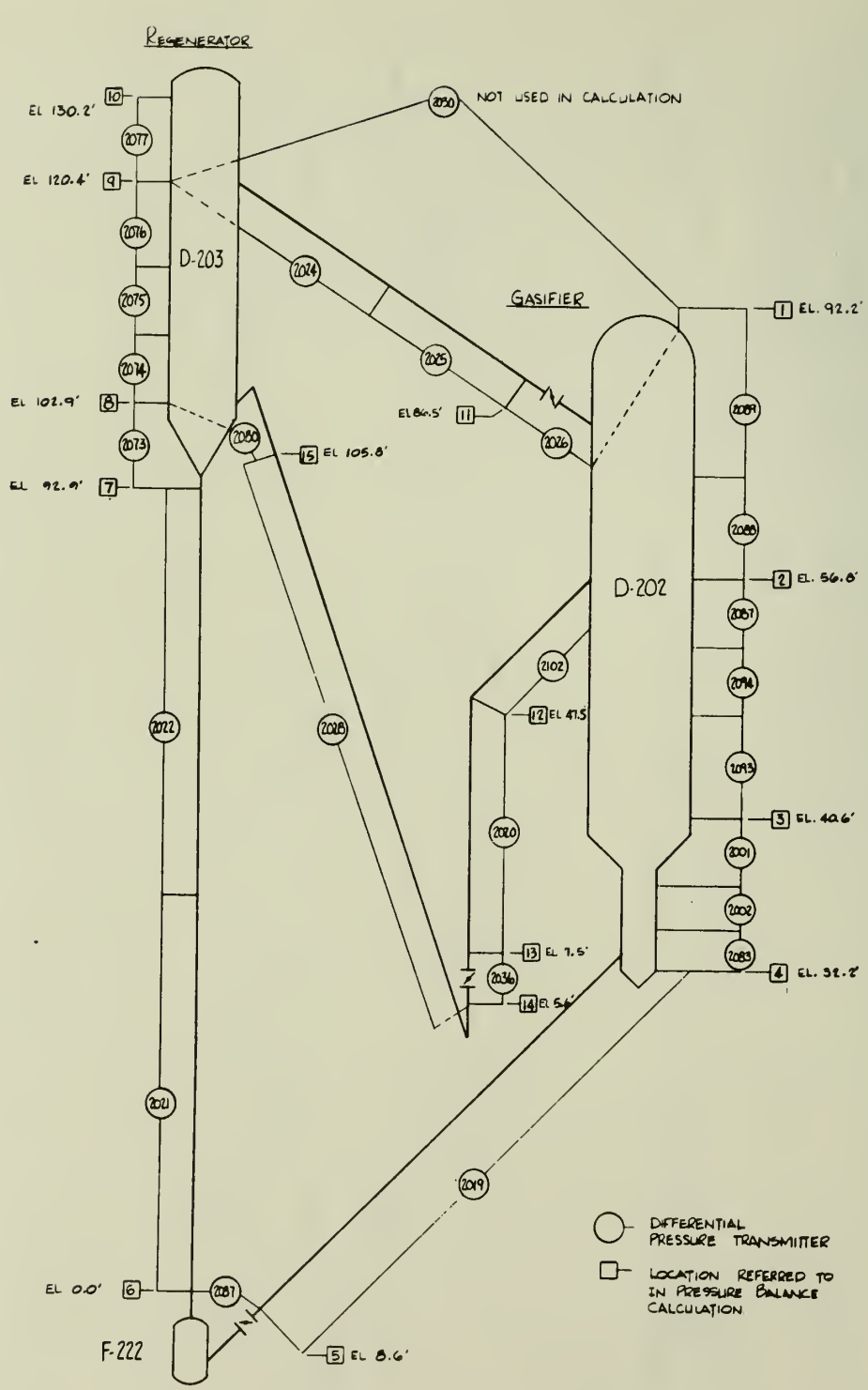


Figure 33-6. DIFFERENTIAL PRESSURE TRANSMITTER LOCATION PRESSURE BALANCE CALCULATION

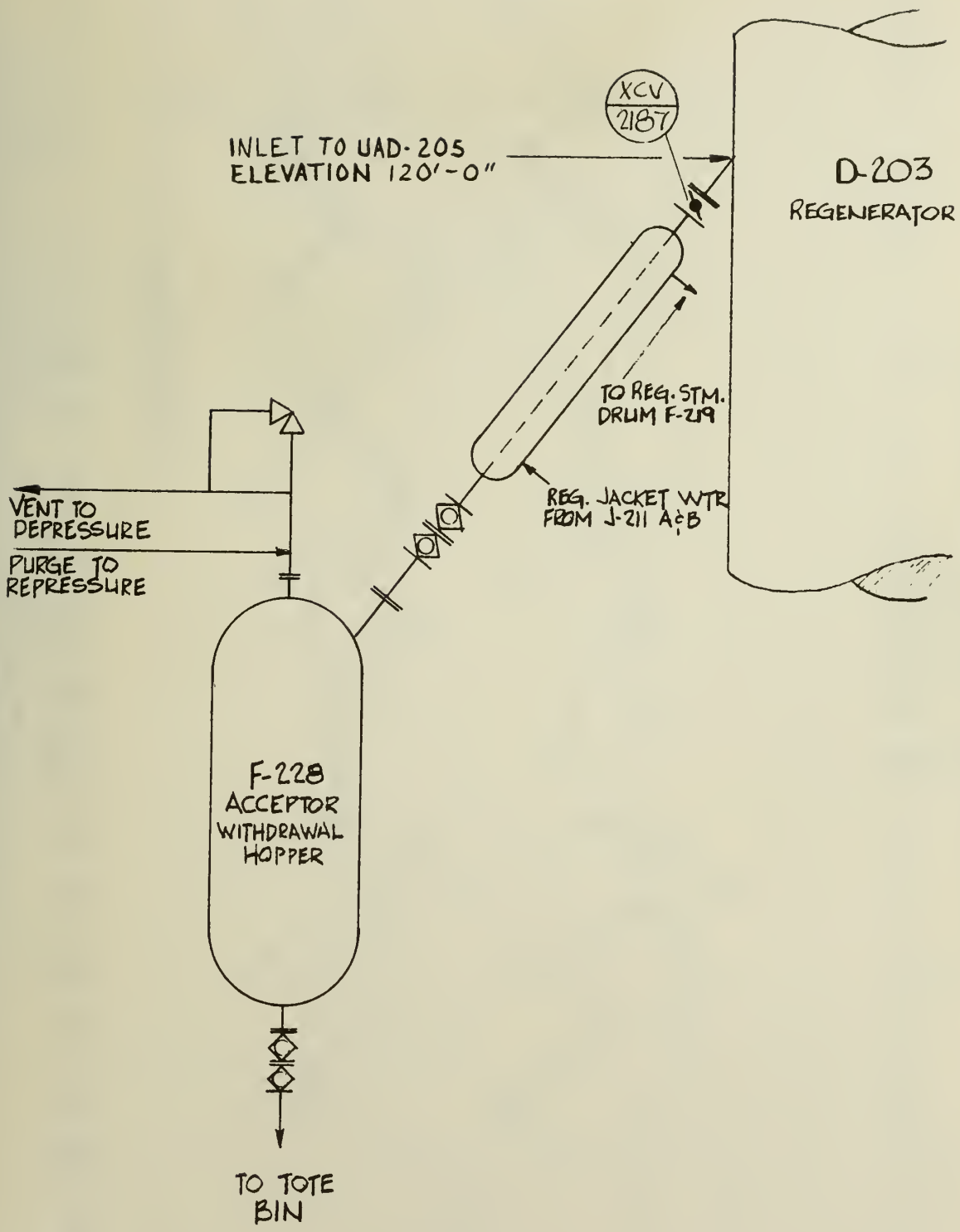


Figure 33-7. ACCEPTOR WITHDRAWAL SYSTEM

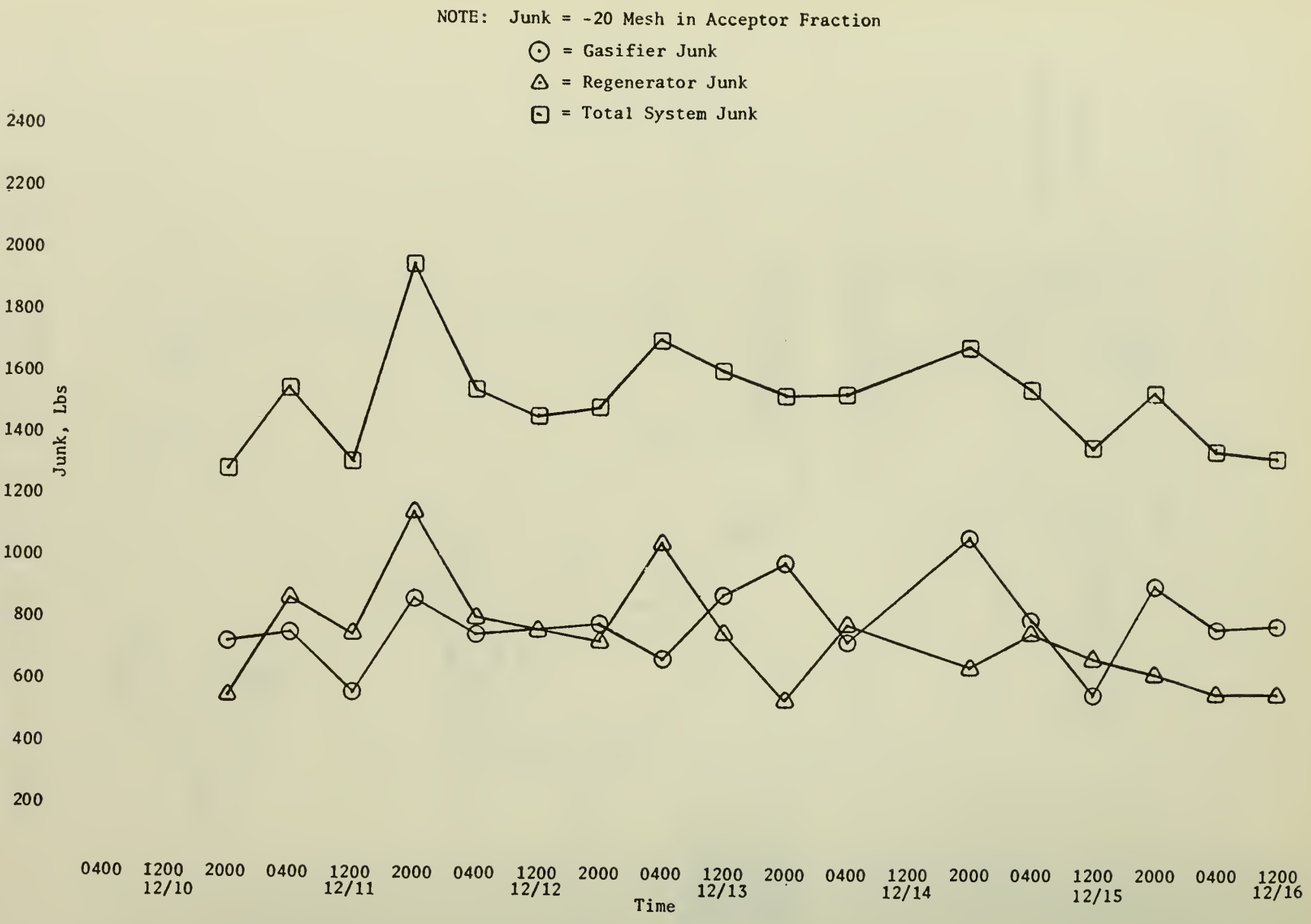


Figure 33-8. SYSTEM JUNK INVENTORY (Sheet 1 of 2)

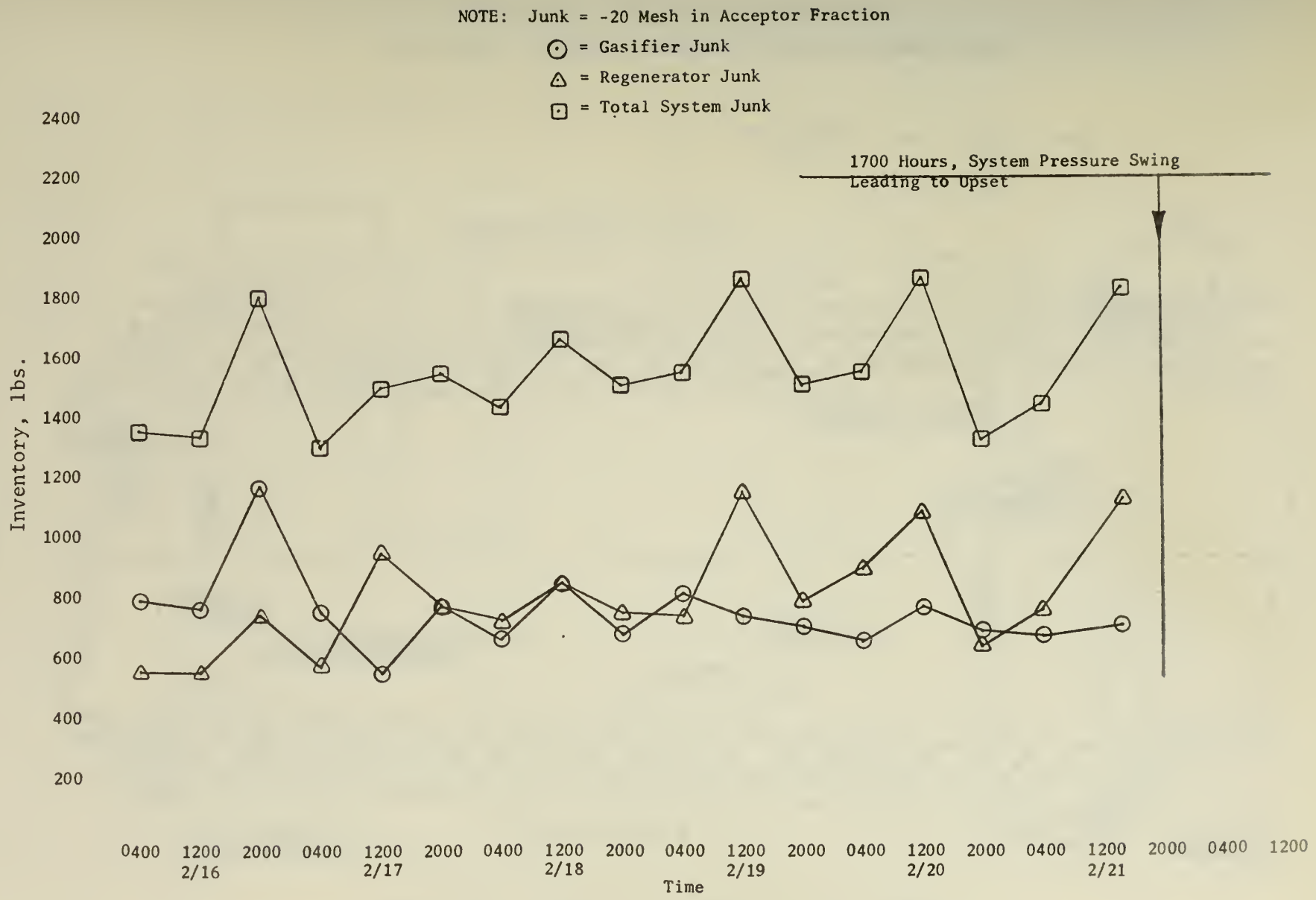
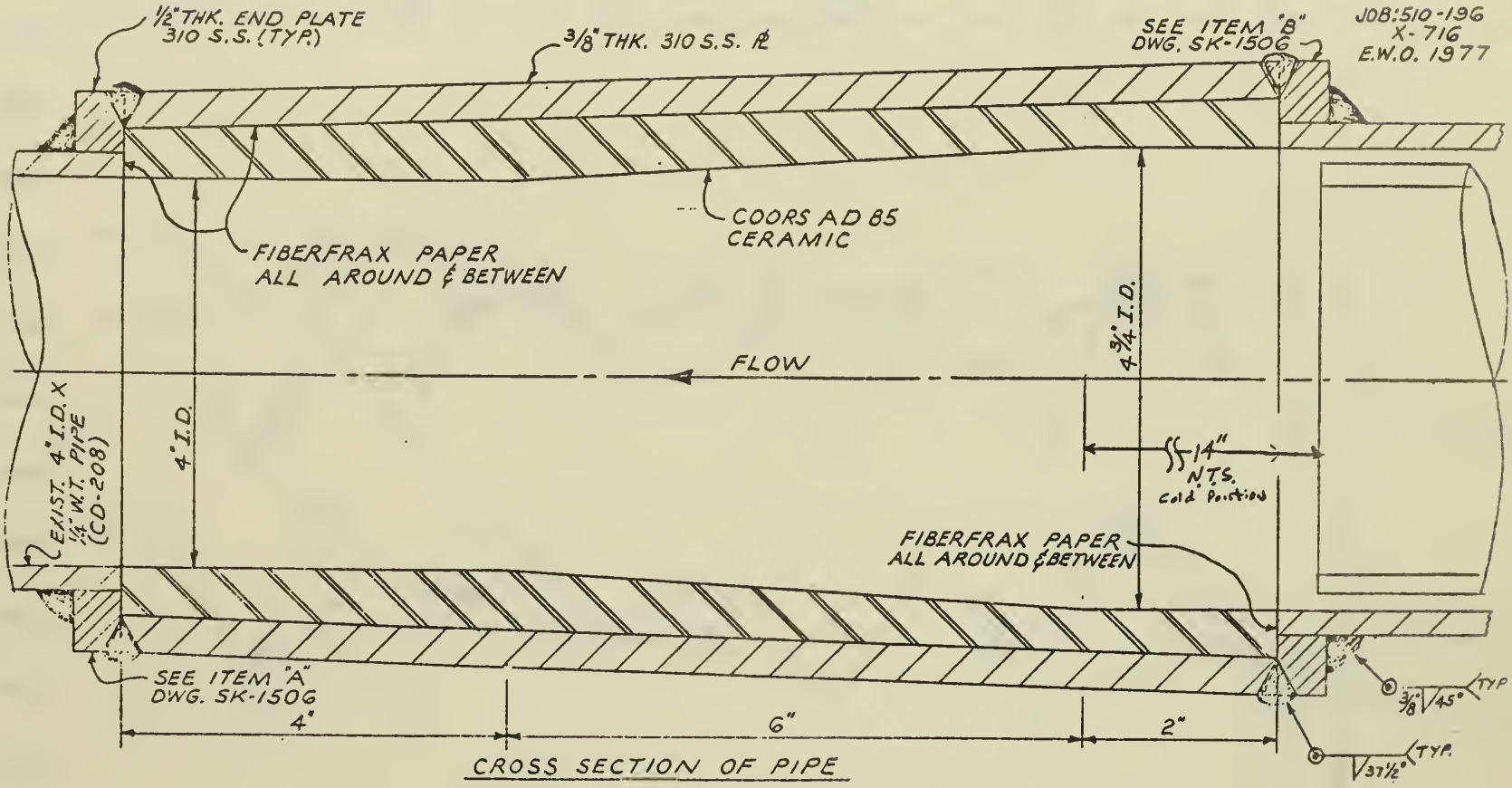


Figure 33-8. SYSTEM JUNK INVENTORY (Sheet 2 of 2)



CROSS SECTION OF PIPE

Figure 33-9. CERAMIC TRANSITION PIECE FOR LINE CD-208

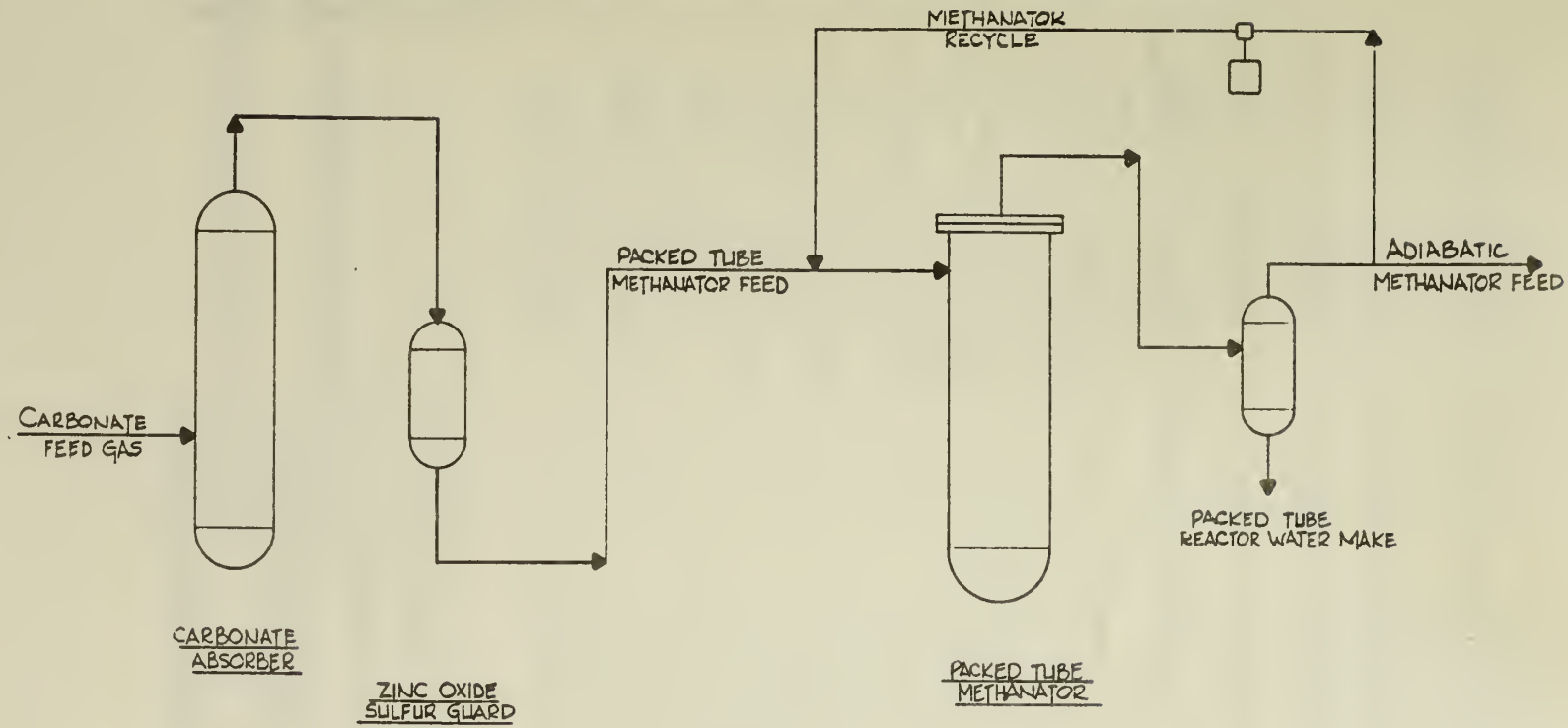


Figure 33-10. METHANATOR SCHEMATIC FLOW DIAGRAM

Date				← 2/11 →				← 2/12 →				← 2/13 →				
Time				0230	0650	0815	1500	0420	0900	1730	2125	0230	0600	0820	1305	2155
dPR-*	Chart	Zero	Range In. W.C.													
2030	-10/10	9.0	554.0	6	5.5	5.8	4.5	4.1	3.8	2.6	2.5	2.5	2.5	2.5	2.6	3.1
2089	0/100	4.2	25.0	3	5	6	4	6	6	4	3	3	3	4	2	3
2088	0/100	3.0	168.7	24	26	27	25	26	28	26	21	22	23	27	21	19
2087	0/100	3.0	43.7	67	67	67	63	67	71	73	74	73	73	73	74	73
2094	0/100	3.0	53.9	60	60	60	59	62	65	69	69	68	68	68	70	71
2093	0/100	3.0	115.4	30	30	30	27	31	32	34	34	34	34	34	35	35
2001	0/100	3.0	126.2	19	19	20	19	20	21	22	21	21	21	21	21.5	21
2002	0/100	3.0	57.1	42	42	42	42	42	41	41	40	40	40	36	36	35
2083	0/100	3.0	57.7	63	62	62	59	57	54	52	51	49	49	48	47	46
2019	0/100	4.2	300.0	29	30	25	36	30	28	40	38	35	34	30	31	28
2037	-10/10	9.0	40.0	-3	-3	-3	-3	-3	-3	-3	-2	-2	-2	-2	-2	-1.8
2021	0/100	4.2	50.0	80	80	80	78	75	80	80	80	75	75	76	81	80
2022	0/100	4.8	25.0	59	58	59	58	55	60	58	59	59	56	55	60	60
2073	0/100	3.0	150.0	48	47	52	43	39	38	37	36	35	34	34	35	33
2074	0/100	3.0	180.0	59	58	65	55	57	53	52	52	50	52	52	48	49
2075	0/100	3.0	180.0	70	69	69	67	61	59	58	56	56	55	54	54	53
2076	0/100	3.0	144.0	51	50	50	48	44	42	42	41	40	39	38	34	39
2077	0/100	3.0	144.0	22	23	18	22	20	18	20	20	20	20	17	20	20
2024	0/100	4.2	98.6	54	50	49	42	37	37	25	23	25	27	27	27	30
2025	0/100	4.2	300.0	47	43	42	37	34	33	23	21	23	23	23	25	27
2026	-10/10	9.0	40.0	-1	-1	-1	-1	-1	-1	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2	-1.1
2102	0/100	4.2	100.0	52	51	50	48	50	54	58	57	57	56	57	55	53
2020	0/100	4.2	300.0	47	52	52	62	55	55	66	65	65	67	62	65	61
2036	-10/10	9.0	20.0	-2	-2	-1.9	-1.8	-2	-2	-2	-2	-2	-2	-2	-2	-2
2028	0/100	4.8	50.0	49	47	50	50	53	53	63	60	59	55	55	63	53
2080	0/100	9.0	40.0	92	92	92	85	86	86	88	87	84	87	86	89	89
Location*				Pressure, In. W.C.**												
1				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2				41.9	45.5	49.7	42.7	46.2	48.0	44.8	37.7	38.0	39.0	46.5	35.6	32.7
3				138.9	144.3	151.8	137.4	145.8	153.7	153.7	147.4	148.3	150.5	158.3	150.3	147.2
4				223.4	229.9	241.6	222.8	228.5	236.6	235.0	226.6	227.5	230.5	235.7	227.8	222.8
5				281.8	292.4	290.6	305.1	290.2	293.1	326.2	312.2	305.1	305.8	299.0	294.3	279.8
6				215.8	286.3	284.3	298.9	284.2	287.0	320.2	308.2	301.1	301.7	294.9	290.1	276.1
7				217.0	228.8	228.6	243.4	229.0	229.0	261.4	249.4	245.6	247.6	240.8	232.4	218.8
8				143.4	158.1	153.2	179.8	169.2	171.6	204.2	194.0	192.4	196.5	189.8	180.1	169.3
9				-158.3	-141.1	-143.5	-113.1	-102.5	-96.0	-55.9	-50.1	-56.2	-56.9	-57.6	-63.1	-72.5
10				-190.6	-175.1	-169.1	-146.4	-132.0	-123.6	-86.0	-78.8	-86.1	-87.4	-83.3	-93.4	-102.6
11				2.0	2.0	2.1	2.0	2.0	2.0	2.2	2.3	2.2	2.4	2.4	2.4	2.2
12				91.5	93.2	94.7	86.1	93.6	98.6	100.5	92.1	91.7	91.2	99.4	86.5	81.7
13				198.7	213.1	210.4	233.2	224.3	227.3	265.0	253.0	250.3	253.9	247.0	242.6	226.6
14				188.6	203.8	201.4	224.4	214.3	217.4	255.0	243.0	240.4	244.2	237.2	232.9	216.8
15				159.8	174.8	170.4	193.9	183.2	185.9	219.0	208.4	205.9	211.3	204.3	195.8	185.0

*Refer to Figure 6.
**Static pressure at Location 1 is 150 psig. Pressures listed are differential pressures from Location 1.

Table 33-1. PRESSURE BALANCE TESTS FOR RUN 33B (Sheet 1 of 4)

Date				2/14						2/15				2/16		
Time				0240	0630	1110	1440	1805	2220	0125	0525	0815	1230	0015	0615	1020
dPR-*	Chart	Zero	Range In. W.C.													
2030	-10/10	9.0	554.0	3.1	3.1	3.1	3	3	3	3	3	3	2.8	2.8	2.8	2.8
2089	0/100	4.2	25.0	3.5	8	5	18	29	27	29	20	27	10	29	18	17
2088	0/100	3.0	168.7	26	28	27	29	30	29	29	29	29	29	29	28	28
2087	0/100	3.0	43.7	73	71	71	71	71	71	71	71	71	71	71	69	70
2094	0/100	3.0	53.9	68	67	66	67	66	65	66	66	66	66	66	63	65
2093	0/100	3.0	115.4	34	33	33	33	33	32	33	33	33	33	33	31.5	32
2001	0/100	3.0	126.2	20	20	20	20	20	20	20	20	20	20	20	19	19.5
2002	0/100	3.0	57.1	35.5	36	35.5	31	31	31	31	31	31	31	31	30.5	30.5
2083	0/100	3.0	57.7	45	44	44	43	42	43	43	43	43	43	43	43	43.5
2019	0/100	4.2	300.0	23	23	25	25	22	23	23	23	22	26	25	29	29
2037	-10/10	9.0	40.0	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.9	-1.9	-1.9	-1.9
2021	0/100	4.2	50.0	80	80	79	79	80	79	78	79	78	78	78	77	78
2022	0/100	4.8	25.0	55	57	57	61	48	59	59	59	58	56	59	58	57
2073	0/100	3.0	150.0	33	33	32.5	32.5	32	32	32	32	31.5	32	33	33	33
2074	0/100	3.0	180.0	49	48	48	47	47	49	46	49	47	49	49	49	49
2075	0/100	3.0	180.0	53	52	53	53	52	52	52	51	51	52	51.5	52	52
2076	0/100	3.0	144.0	39	39	38	40	39	38	38	37	37	38	38	39	39
2077	0/100	3.0	144.0	20	20	20	29	20	20	20	19	20	20	15	20	20
2024	0/100	4.2	98.6	32	31	32	30	31	30	30	30	31	29	30	30	30
2025	0/100	4.2	300.0	27	27	27	27	27	26	27	27	26	25	25	25	25
2026	-10/10	9.0	40.0	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2	-1.1	-1.1
2102	0/100	4.2	100.0	53	54	51	51	49	49	51	51	51	51	52	52	51
2020	0/100	4.2	300.0	60	55	58	54	52	52	55	53	54	55	54	56	57
2036	-10/10	9.0	20.0	-1.9	-2	-2	-2	-1.9	-1.8	-1.8	-1.8	-1.9	-1.9	-1.9	-1.9	-1.9
2028	0/100	4.8	50.0	53	45	49	49	50	50	50	50	50	51	53	53	54
2080	0/100	9.0	40.0	90	92	93	91	92	92	93	92	91	92	91	93	92
Location*				Pressure, In. W.C.**												
1				0	0	0	0	0	0	0	0	0	0	0	0	0
2				44.1	48.6	45.9	53.0	57.2	56.4	54.4	53.3	54.4	51.7	56.0	51.7	51.2
3				158.9	159.3	154.4	161.7	165.2	161.7	164.0	162.0	164.0	159.3	164.2	155.1	156.5
4				234.8	234.1	228.6	231.5	234.3	231.7	234.8	232.2	234.8	228.8	234.0	223.1	225.4
5				277.6	276.4	277.0	279.2	272.7	273.2	276.9	273.9	273.7	279.3	281.7	282.8	285.0
6				273.8	272.6	273.2	275.5	269.0	269.6	273.2	270.2	270.0	275.1	277.8	279.0	281.1
7				219.4	217.0	217.8	218.2	214.4	212.8	217.7	213.7	214.7	219.5	221.4	223.2	225.0
8				171.3	168.2	169.6	169.2	166.0	164.7	170.2	165.7	167.8	171.0	171.7	173.3	175.0
9				-73.5	-72.6	-73.1	-72.0	-72.7	-70.5	-70.3	-71.8	-68.8	-65.8	-66.2	-66.6	-66.2
10				-104.0	-103.1	-103.8	-115.4	-103.2	-100.2	-101.4	-100.8	-99.6	-95.8	-89.2	-96.7	-96.5
11				2.2	2.2	2.2	2.2	2.2	2.2	2.1	2.2	2.4	2.4	2.4	2.2	2.2
12				91.7	97.8	92.4	100.3	102.7	101.7	101.0	100.4	101.1	99.3	104.3	100.2	99.7
13				229.5	223.1	226.9	225.2	221.9	220.5	226.9	221.7	224.2	227.7	229.2	231.4	233.1
14				220.5	213.5	217.3	215.4	212.6	211.8	218.2	213.0	215.1	218.4	219.9	222.1	223.8
15				187.8	185.4	187.1	185.7	182.4	181.5	187.6	182.6	184.5	187.8	188.2	190.4	191.7

*Refer to Figure 6.
**Static pressure at Location 1 is 150 psig. Pressures listed are differential pressures from Location 1.

Table 33-1. PRESSURE BALANCE TESTS FOR RUN 33B (Sheet 2 of 4)

Date				2/16		← 2/17					← 2/18 →			← 2/19 →		
Time				1810	2235	0210	0455	1415	2110	2305	0230	0510	1430	0245	0515	0855
dPR-*	Chart	Zero	Range In. W.C.													
2030	-10/10	9.0	554.0	2.8	1.7	2.8	2.8	2.8	2.8	2.5	2.8	2.8	2.8	2.8	2.8	3
2089	0/100	4.2	25.0	6	5	5	5	5	5	5	5	5	5	5	5	5
2088	0/100	3.0	168.7	27	26	26	26	27	23	22	22	23	23	14	14	12
2087	0/100	3.0	43.7	72	68	68	67	69	69	69	71	71	70	74	74	74
2094	0/100	3.0	53.9	67	68	68	67	69	69	69	71	71	72	74	74	73
2093	0/100	3.0	115.4	33	34	34	34	34.5	34	34	36	36	36	37	37	36
2001	0/100	3.0	126.2	21	21	22	22	22	21	21	21	22	22	23	23	22
2002	0/100	3.0	57.1	31	31	31	31	31	31	31	31	31	31	30	31	31
2083	0/100	3.0	57.7	44	44	44	44	45	45	45	44	44	45	45	45	45
2019	0/100	4.2	300.0	29	30	31	29	30	33	34	32	31	33	37	39	37
2037	-10/10	9.0	40.0	-1.9	-1.8	-1.8	-1.7	-1.7	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.9
2021	0/100	4.2	50.0	78	80	80	80	83	80	80	80	82	82	82	81	80
2022	0/100	4.8	25.0	57	58	58	59	59	59	59	60	58	58	61	60	60
2073	0/100	3.0	150.0	33	33	32	25	33	33	33	34	34	35	35	35	34
2074	0/100	3.0	180.0	50	50	50	51	51	51	51	50	51	50	51	51	51
2075	0/100	3.0	180.0	52	52	53	52	53	53	53	54	53	54	54	55	55
2076	0/100	3.0	144.0	38	39	39	39	39	39	39	39	39	39	39	40	39
2077	0/100	3.0	144.0	17	19	20	18	17	18	19	18	19	19	18	19	18
2024	0/100	4.2	98.6	30	30	30	30	30	30	30	30	30	30	30	30	32
2025	0/100	4.2	300.0	25	25	25	25	25	25	25	25	25	25	24	24	24
2026	-10/10	9.0	40.0	-1	-1.2	-1.1	-1.1	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2
2102	0/100	4.2	100.0	50	47	49	50	52	51	51	54	57	56	58	58	57
2020	0/100	4.2	300.0	59	60	61	60	62	62	63	62	62	64	70	72	70
2036	-10/10	9.0	20.0	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.9	-1.8	-1.8	-1.8	-1.9	-1.8
2028	0/100	4.8	50.0	54	54	53	55	55	56	56	56	56	61	63	63	59
2080	0/100	9.0	40.0	92	91	93	90	90	92	92	90	90	93	94	94	96
Location*				Pressure, In. W.C.**												
1				0	0	0	0	0	0	0	0	0	0	0	0	0
2				46.6	45.1	44.6	44.6	46.0	39.9	37.9	38.2	39.6	39.3	24.5	24.3	21.3
3				155.1	152.3	152.5	150.5	157.4	148.6	146.6	152.1	154.5	153.5	143.1	142.6	138.3
4				226.4	223.5	224.8	222.1	231.4	220.1	218.1	223.5	227.9	227.0	217.5	217.2	211.9
5				286.0	286.1	290.1	280.9	294.8	291.4	292.5	292.3	294.2	299.0	302.0	307.6	296.5
6				282.1	282.5	286.5	277.5	291.3	287.8	288.8	288.6	290.6	295.3	298.3	304.0	292.6
7				225.9	225.0	228.8	219.0	232.9	229.8	230.8	230.8	232.8	237.1	239.5	245.7	235.0
8				175.9	175.0	180.0	180 3	183.5	179.4	180.4	179.3	181.8	184.3	186.9	192.9	183.9
9				-66.2	-66.4	-65.9	-65.8	-65.6	-66.4	-65.9	-66.3	-65.7	-65.2	-62.7	-62.2	-65.2
10				-92.2	-95.1	-96.3	-93.4	-91.7	-93.7	-94.9	-93.5	-94.7	-94.4	-90.2	-91.2	-92.4
11				2.0	2.4	2.2	2.2	2.2	2.2	2.2	2.4	2.4	2.4	2.4	2.4	2.4
12				93.2	88.8	90.4	91.8	94.0	87.8	85.8	88.7	92.5	91.6	78.6	78.6	74.4
13				233.6	232.2	237.4	237.1	241.3	237.9	238.0	237.8	240.1	246.1	250.3	256.6	246.0
14				224.7	223.3	238.5	228.2	232.6	229.0	230.0	228.4	231.4	237.3	241.5	247.3	237.3
15				192.6	191.3	197.1	196.0	199.6	196.1	197.1	195.3	197.9	201.5	204.5	210.5	202.4

*Refer to Figure 6.
**Static pressure at Location 1 is 150 psig. Pressures listed are differential pressures from Location 1.

Table 33-1. PRESSURE BALANCE TESTS FOR RUN 33B (Sheet 3 of 4)

Date				2/19				2/20						2/21			
Time				1450	1850	2130	2330	0215	0435	0705	1150	1520	1900	0225	0500	0740	1510
dPR-*	Chart	Zero	Range In. W.C.														
2030	-10/10	9.0	554.0	3.5	3.4	3.5	3.6	3.5	3.5	3.5	3.5	3.5	4.1	3.5	3.4	3.5	3.5
2089	0/100	4.2	25.0	5	5	5	5	6	6	6	10	12	24	6	6	5	5
2088	0/100	3.0	168.7	18	21	23	25	27	28	27	27.5	27.5	28	26	26	25	19
2087	0/100	3.0	43.7	72	71	70	69	68	67	67	66	65	64	65	67	66	67
2094	0/100	3.0	53.9	73	71	70	69	68	67	67	66	65	64	65	67	66	67
2093	0/100	3.0	115.4	36	35	34.5	34	34	33	33	33	32.5	32	32	33	33	33
2001	0/100	3.0	126.2	21.5	21	21	21	21	20	20	20	19.5	29	19	20	21	21
2002	0/100	3.0	57.1	31	31	31	31	31	30	30	30.5	31	31	30	31	31	31
2083	0/100	3.0	57.7	45	45	45	46	46	46	46	46	46	46	45	45	46	46
2019	0/100	4.2	300.0	30	30	32	30	30	30	32	33	33	25	34	31	32	37
2037	-10/10	9.0	40.0	-1.8	-1.8	-1.8	-1.8	-1.7	-1.8	-1.8	-1.9	-1.9	-2.5	-1.8	-1.8	-1.8	-1.9
2021	0/100	4.2	50.0	80	80	80	80	83	83	83	83	84	84	83	83	83	83
2022	0/100	4.8	25.0	61	58	58	59	59	60	58	60	61	60	59	60	59	57
2073	0/100	3.0	150.0	35	35	36	36	36	36	37	36	36	36	37	36	36	36
2074	0/100	3.0	180.0	51	52	53	53	52	52	52	51	51	53	52	55	54	51
2075	0/100	3.0	180.0	55	55	56	55	55	55	56	56	56	55	55	55	53	54
2076	0/100	3.0	144.0	40	40	41	41	41	41	42	41	41	39	41	40	41	40
2077	0/100	3.0	144.0	18	17	19	20	20	19	20	19	21	15	18	17	17	17
2024	0/100	4.2	98.6	35	35	35	35	35	35	35	35	34	38	32	32	32	32
2025	0/100	4.2	300.0	29	28	28	28	27	28	28	28	28	33	28	29	28	28
2026	-10/10	9.0	40.0	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.1	-1.2	-1.2	-1.2	-1.1
2102	0/100	4.2	100.0	57	55	54	57	57	55	55	54	54	52	53	53	53	53
2020	0/100	4.2	300.0	63	61	62	61	58	59	58	59	57	46	64	60	60	60
2036	-10/10	9.0	20.0	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-2	-1.9	-0.9	-1.6	-1.5	-1.6	-1.6
2028	0/100	4.8	50.0	58	58	58	58	58	56	54	55	56	55	58	60	55	54
2080	0/100	9.0	40.0	95	95	95	95	95	95	95	94	94	95	97	95	92	95
Location*				Pressure, In. W.C.**													
1				0	0	0	0	0	0	0	0	0	0	0	0	0	0
2				31.0	36.6	39.9	43.0	47.1	48.3	47.1	48.1	49.3	53.1	44.5	45.6	43.3	33.1
3				148.0	149.9	151.4	154.3	156.2	156.3	153.0	152.6	151.6	151.1	150.3	153.2	149.7	137.5
4				221.6	222.2	223.6	228.0	229.1	228.1	224.1	223.7	221.9	231.4	220.8	224.6	223.0	208.7
5				285.2	285.2	292.6	291.6	292.1	291.8	293.3	295.7	293.6	277.4	297.6	291.1	292.5	291.2
6				281.5	281.6	289.0	287.9	288.6	288.1	289.6	291.8	289.7	272.5	293.8	287.4	288.8	287.4
7				224.2	224.5	231.8	231.2	229.8	229.7	231.1	232.6	229.4	210.8	236.2	228.8	230.3	227.7
8				172.0	171.9	177.6	177.7	175.7	176.2	175.6	178.3	174.8	154.7	181.8	175.0	176.4	172.2
9				-81.9	-80.1	-79.9	-79.5	-77.2	-79.4	-80.3	-78.9	-79.0	-98.0	-76.0	-80.8	-77.2	-77.2
10				-109.5	-105.9	-108.6	-109.8	-107.3	-108.3	-110.3	-108.0	-110.6	-121.0	-103.6	-106.4	-103.0	-103.1
11				2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.2	2.4	2.4	2.4	2.2
12				83.7	87.8	90.2	95.6	100.3	98.9	98.3	98.5	100.0	103.2	92.8	94.5	92.3	83.5
13				233.6	233.1	238.7	239.4	236.9	236.8	234.7	238.4	234.7	208.3	243.7	236.0	234.1	229.4
14				224.9	224.3	229.9	230.7	228.1	228.1	226.0	228.6	225.4	203.8	236.1	228.7	226.3	221.4
15				190.2	190.0	195.6	196.0	193.7	194.5	193.6	195.9	192.3	172.2	201.1	193.2	193.3	189.9

*Refer to Figure 6.
**Static pressure at Location 1 is 150 psig. Pressures listed are differential pressures from Location 1.

Table 33-1. PRESSURE BALANCE TESTS FOR RUN 33B (Sheet 4 of 4)

Date	Time	Pressure Drop Factor, ΔP/ρL Overall	Sloped Section	Vertical Section
2/11	0230	0.501	0.561	0.481
	0650	0.547	0.547	0.546
	0815	0.543	0.534	0.546
	1500	0.657	0.525	0.700
2/12	0420	0.554	0.517	0.567
	0900	0.549	0.551	0.549
	1730	0.624	0.565	0.643
	2125	0.612	0.554	0.631
2/13	0230	0.612	0.554	0.631
	0600	0.627	0.542	0.654
	0820	0.586	0.554	0.597
	1305	0.589	0.515	0.613
	2155	0.550	0.492	0.569
2/14	0240	0.557	0.507	0.574
	0630	0.533	0.534	0.532
	1110	0.550	0.498	0.568
	1440	0.515	0.498	0.520
	1805	0.491	0.473	0.497
	2220	0.506	0.488	0.512
2/15	0125	0.524	0.498	0.532
	0525	0.506	0.498	0.509
	0815	0.515	0.498	0.520
	1230	0.524	0.498	0.532
2/16	0015	0.518	0.510	0.520
	0615	0.561	0.534	0.570
	1020	0.559	0.513	0.573
	1810	0.556	0.485	0.579
	2235	0.540	0.436	0.574
2/17	0210	0.555	0.459	0.585
	0455	0.549	0.471	0.574
	1415	0.564	0.488	0.588
	2110	0.569	0.483	0.597
	2305	0.578	0.483	0.608
2/18	0230	0.546	0.490	0.564
	0510	0.554	0.523	0.564
	1430	0.567	0.512	0.585
2/19	0245	0.605	0.520	0.633
	0515	0.621	0.520	0.654
	0855	0.619	0.523	0.650
	1450	0.562	0.523	0.575
	1850	0.556	0.515	0.569
	2130	0.569	0.511	0.588
	2330	0.561	0.554	0.585
2/20	0215	0.552	0.554	0.551
	0435	0.571	0.546	0.580
	0705	0.562	0.546	0.568
	1150	0.568	0.534	0.579
	1520	0.559	0.542	0.564
	1900	0.460	0.526	0.439
2/21	0225	0.629	0.538	0.659
	0500	0.574	0.522	0.591
	0740	0.574	0.522	0.591
	1510	0.574	0.522	0.591

Table 33-2. CHAR STANDLEG PRESSURE DROP FACTORS FOR RUN 33B

Date	← 1/27 →			← 1/28 →			← 1/29 →			1/30
Time	0300	1100	1930	0300	1100	1900	0300	1100	1900	0300
Solids										
Feedstock	← Char →		← Velva Lignite →							
Feed Rate, lb/hr[1]	1,740	1,530	1,670	2,050	2,170	2,290	2,290	2,290	2,290	2,290
Recovered Overhead Solids, lb/hr	-	200	200	200	200	180	170	180	180	75
Solids to Organic Pond, lb/hr	30	35	30	30	45	40	25	35	30	30
Reject Acceptor, lb/hr	0	0	0	0	0	0	0	0	0	0
Char Withdrawal, lb/hr	0	0	0	0	0	0	0	0	0	0
Gas Flows[2]										
Boot Recycle, MSCFH	34.4	24.1	19.7	19.2	17.7	14.3	12.8	0	0	0
Boot Steam, MSCFH	21.1	15.4	16.3	16.4	18.4	21.5	21.8	34.3	33.6	35.0
Boot CO_2, MSCFH	0	0	0	0	0	0	0	0	1.0	1.0
Side Steam, MSCFH	31.4	31.2	31.6	31.4	29.7	29.1	28.3	19.8	19.7	17.6
Side Air, MSCFH	16.4	20.1	20.7	20.8	20.7	15.1	12.7	6.4	3.3	0
Recycle Purge, MSCFH	2.1	2.2	2.3	2.3	2.3	2.4	2.5	2.7	2.9	2.9
Inert Purge, MSCFH	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total Inlet, MSCFH	105.6	93.2	90.8	90.3	89.0	82.6	78.3	63.4	60.7	56.7
Vent, MSCFH	38.5	45.9	66.6	85.5	78.3	62.0	61.5	57.0	52.9	46.9
Bed Conditions										
Boot Velocity, ft/sec[3]	2.4	1.8	1.8	1.8	1.7	1.8	1.7	1.8	1.8	1.9
Char Bed Velocity, ft/sec[3]	1.0	0.9	0.9	0.9	0.9	0.9	0.8	0.6	0.6	0.6
Boot Density, lb/ft^3[4]	105	110	105	105	105	101	92	87	81	81
Char Bed Density, lb/ft^3[4]	52	43	40	33	32	29	29	30	30	31
Char Bed Height, ft[4]	-	-	24.8	24.0	20.0	23.0	25.0	23.6	25.0	24.6
Average Boot Temperature, °F	1225	1350	1385	1430	-	-	-	1495	1485	1480
Average Bed Temperature, °F	1375	1435	1510	1500	1500	1500	1510	1505	1490	1480
Overhead Gas Compositions, Dry Mol %										
CO	11.4	12.1	17.2	18.1	20.3	19.6	18.8	16.5	15.1	13.7
CO_2	18.3	18.8	16.4	16.5	13.0	12.2	10.6	10.2	10.8	11.0
N_2	43.6	34.8	29.7	25.5	26.0	21.0	18.7	12.0	3.9	4.2
H_2	20.9	29.9	33.3	34.1	34.4	39.9	43.7	51.1	57.7	58.4
CH_4	5.9	4.4	3.4	5.8	6.3	7.6	8.2	10.2	12.3	12.7

(1) Determined by feeder RPM measurements; for char, lb/hr = 420*RPM; for lignite, lb/hr = 417*RPM
(2) Determined by orifice flow meter measurements
(3) Based on inlet gas flow rates
(4) Indicated by pressure tap measurements

Table 33-3. GASIFIER DATA FOR RUN 33A

Date	← 1/27 →			← 1/28 →			← 1/29 →			1/30
Time	0300	1100	1930	0300	1100	1900	0300	1100	1900	0300
Solids										
Acceptor Feedstock	← Dead-Burned Dolomite →								Minnekahta Limestone	
Acceptor Makeup Rate, lb/hr(1)	420	280	280	280	420	560	560	560	560	560
Auxiliary Fuel Char, lb/hr(1)	0	120	120	140	450	160	240	380	200	190
Acceptor Circulation, lb/hr(2)	3,300	5,100	1,150	12,400	13,100	12,400	13,000	13,600	13,600	14,300
Reject Acceptor, lb/hr	390	490	305	400	380	535	430	590	390	-
Ash and Attrited Acceptor, lb/hr	-	-	-	-	-	-	140	140	-	-
Gas Flows(3)										
Acceptor Lift Recycle, MSCFH	58.1	56.5	57.1	57.0	56.9	56.2	56.0	54.7	55.4	55.9
Char Lift, MSCFH(4)	7.1	9.8	9.8	9.8	9.8	9.8	9.9	9.9	9.8	10.0
Recycle to Air Line MSCFH	80.4	44.8	26.4	25.2	21.0	15.6	0	0	0	0
Air, MSCFH	47.2	53.3	51.9	55.6	55.9	69.5	68.2	76.9	73.8	80.7
Recycle Purge, MSCFH	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Nitrogen Purge, MSCFH	2.3	1.9	1.9	1.6	1.5	2.2	1.9	2.1	1.8	1.7
Total Inlet, MSCFH	197.7	168.8	149.6	151.7	147.6	155.8	138.5	146.1	143.3	150.8
Vent to Elliott Test Fixture, MSCFH	0	0	0	0	0	0	0	0	0	0
Total Vent, MSCFH	61.3	66.2	59.8	68.6	67.9	98.7	86.1	103.6	97.4	122.0
Bed Conditions										
Gas Velocity, ft/sec(5)	3.3	3.1	2.7	2.8	2.7	2.8	2.5	2.7	2.6	2.7
Bed Density, lb/ft3(6)	99	97	97	97	98	93	86	82	75	75
Bed Height, ft(6)	18.6	19.7	19.2	19.5	19.1	19.7	19.5	20.0	19.2	20.0
Average Bed Temperature, °F	1635	1860	1860	1855	1840	1840	1835	1855	1840	1820
Overhead Gas Compositions, Dry Mol %										
O_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	3.9	4.1	1.9	4.4	6.4	2.0	4.4	3.1	0.4
CO_2	12.9	17.0	17.3	19.0	17.6	22.6	26.6	23.4	26.7	24.5
N_2	87.1	79.1	78.6	79.1	78.0	71.0	71.4	72.2	70.2	75.1

(1) Determined by feeder RPM measurements: for acceptor, lb/hr = 280*RPM; for auxiliary fuel, lb/hr, 345.7*RPM
(2) Determined by lift line pressure drop measurements
(3) Determined by orifice flow meter measurements
(4) Char lift is approximately 7.0 MSCFH inert gas and the remainder recycle
(5) Based on inlet gas flow rates
(6) Indicated by pressure tap measurements

Table 33-4. REGENERATOR DATA FOR RUN 33A

Date 1/23/76 - 1/31/76

Screen Size, Wt % Tyler Mesh	Acceptor Minnekahta Limestone	Screen Size, Wt % Tyler Mesh	Lignite	
			Husky Char	Velva Lignite
+4		+6		
4 X 6	1.1	6 X 8	0.6	2.3
6 X 8	25.7	8 X 10	1.9	4.6
8 X 9	30.9	10 X 14	8.8	12.7
9 X 10	27.5	14 X 20	13.8	14.7
10 X 12	11.5	20 X 28	14.0	16.5
12 X 14	2.3	28 X 35	16.5	14.9
14 X 16	0.4	35 X 48	14.5	14.6
16 X 20	0.1	48 X 65	8.9	9.9
20 X 24	Tr	65 X 100	6.0	5.5
24 X 28	Tr	100 X 200	6.6	3.6
-28	0.5	-200	8.4	0.7
Particle Density, lb/cu ft	132			
Calcine Weight Loss, %	42.8			
Ultimate Analysis, Wt %				
Moisture			2.0	0.8
C			73.6	65.7
H + Moisture H			2.3	4.3
N			0.7	0.8
S			1.50	0.68
Ash + SO_3			18.28	6.77
Elemental Analysis, Wt %				
SiO_2	3.07		39.45	20.99
SO_3	0.02		20.25	15.29
Na_2O	0.06		2.88	1.65
CaO	95.20		15.98	35.96
MgO	1.03		4.85	10.04
K_2O	0.06		0.39	0.29
P_2O_5	0.03		0.03	0.13
Al_2O_3	0.27		8.40	10.76
Fe_2O_3	0.33		4.33	5.20
TiO_2	0.02		0.41	0.43

Table 33-5. FEEDSTOCK COMPOSITES FOR RUN 33A

Calcined Acceptor

Date	1/27		← 1/28 →			← 1/29 →			1/30	
Time	0800	1600	0000	0800	2000	0000	0800	1930	0000	0400
Screen Size, Wt % Tyler Mesh										
+4										
4 X 9	1.0	2.1	2.3	1.2	1.7	9.0	14.4	21.2	25.2	30.9
9 X 12	50.4	57.3	54.9	52.0	53.5	50.4	47.2	50.3	50.1	47.8
12 X 20	48.0	39.8	41.3	44.8	41.0	37.0	32.1	23.6	20.0	17.7
20 X 28	0.5	0.8	1.0	1.3	1.2	1.7	2.3	2.2	2.7	1.9
-28	0.1	Tr	0.5	0.7	2.6	1.9	4.0	2.7	2.0	1.7

Recarbonated Acceptor

Date	1/27		← 1/28 →			← 1/29 →			1/30	
Time	0800	1600	0000	0800	1600	0000	0800	1600	0000	0415
Screen Size, Wt % Tyler Mesh										
+4										
4 X 9	1.0	1.0	0.7	0.4	2.7	9.4	12.8	19.1	22.4	24.1
9 X 19	49.1	46.0	52.7	48.6	47.3	45.6	49.9	48.8	50.8	49.8
19 X 20	48.8	52.0	45.0	50.0	48.9	43.0	35.6	30.0	24.5	23.0
20 X 28	0.9	1.1	1.1	0.9	1.1	1.5	1.2	1.5	1.4	2.1
-28	0.2	Tr	0.5	0.1	0.2	0.4	0.4	0.6	0.9	1.0

Table 33-6. CIRCULATING ACCEPTOR FOR RUN 33A

Date	1/27		← 1/28 →			← 1/29 →			1/30
Time	1125	2000	0445	1300	2000	0415	1000	1600	0000
Screen Size, Wt % Retained on Tyler Mesh									
4									
6									
8									
9	0.5	0.4	0.2	0.1	11.8	2.2	4.7	7.1	9.8
10									
12	42.9	43.5	47.0	43.6	51.3	49.3	54.8	59.5	61.1
14									
16									
20	55.6	54.9	51.6	55.2	35.2	46.6	38.4	31.7	26.2
24									
28	0.8	0.8	0.8	1.1	1.1	1.3	1.2	1.1	1.6
Pan	0.2	0.4	0.4	0.1	0.6	0.6	0.9	0.7	1.2

Table 33-7. REJECT ACCEPTOR WITHDRAWAL FOR RUN 33A

Date	1/27		1/27		1/28		1/28		1/28		1/29		1/29	
Time	1200		2000		0400		0800		1800		0400		0400	
Sample Point Location	Bed		Bed		Transition		Bed		Bed		Bed		Transition	
Sample Portion	Total	Accep.	Total	Accep.	Total	Accep.	Total	Accep.	Total	Accep.	Total	Accep.	Total	Accep.
Screen Size, Wt % Retained on Tyler Mesh														
8				0.2	0.5	2.4	0.3		1.0	3.3	2.0	4.5	1.2	1.3
9		3.9		1.4		2.4		1.3		5.4		5.0		2.4
10	1.6		1.9		4.2		1.5		3.4		7.0		4.2	
12		45.7		49.8		35.0		49.5		33.2		39.6		27.6
14	22.4	17.8	32.1	18.0	25.0	20.4	28.6	18.3	25.5	17.5	25.8	17.2	20.4	14.2
20	15.0	12.3	13.6	15.7	13.3	16.7	15.6	15.8	13.6	19.1	11.3	13.3	10.4	13.1
28	13.6	3.8	11.0	3.6	10.5	7.3	9.5	4.4	8.5	3.7	8.2	3.7	9.0	8.8
35	15.9		13.2		12.7		14.0		11.9		11.1		13.1	
48	14.2		12.2		13.2		14.9		14.3		14.5		16.3	
65	9.0	14.8	7.9	10.1	9.5	14.9	9.5	10.0	9.8	16.0	10.2	15.7	12.0	29.1
80		1.3		0.8		0.6		0.7		1.2		0.8		2.4
100	6.2		5.2		6.4		4.6		6.4		6.3		7.8	
200	2.0		2.6		3.6		1.2		3.4		2.5		3.6	
Pan	0.1	0.4	0.3	0.4	1.1	0.3	0.3		2.2	0.6	1.1	0.2	2.0	1.1
Acceptor Portion, Wt %	41.0		53.8		27.5		54.1		40.4		54.2		33.6	
Ash + SO_3, Wt % in Char	8.38		12.12		11.98		10.88		15.99		17.36		8.20	

Table 33-8. GASIFIER CHAR BED MATERIAL FOR RUN 33A

Date	1/27	1/28	1/29	1/30
Screen Size, Wt %				
Tyler Mesh				
+60	1.3	1.1	Tr	0.8
60 X 100	17.0	27.4	36.2	26.9
100 X 325	67.5	65.8	13.5	48.9
-325	14.2	5.7	50.3	23.4
Ultimate Analysis, Wt %				
C	51.3	55.0	63.8	69.0
H	1.4	0.9	0.8	1.0
N	0.27	0.24	0.22	0.26
S	1.06	0.70	0.84	0.81
Ash + SO_3	44.15	33.80	27.89	23.77
Elemental Analysis, Wt %				
SiO_2	36.31	16.77	16.55	18.73
SO_3	6.97	7.78	6.50	9.10
Na_2O	2.37	1.23	1.18	1.00
CaO	28.77	46.16	47.68	46.33
MgO	5.11	6.81	4.57	4.11
K_2O	0.22	0.12	0.13	0.18
P_2O_5	0.30	0.45	0.95	0.72
Al_2O_3	13.08	11.57	14.08	11.61
Fe_2O_3	6.05	6.06	7.03	6.87
TiO_2	0.44	0.40	0.41	0.33

Table 33-9. GASIFIER QUENCH TOWER SOLIDS COMPOSITES FOR RUN 33A

Date	1/29	1/30	1/30
Time	1330	0400	0400
Hopper	B	B	A
Screen Size, Wt %			
Tyler Mesh			
+35	2.4	2.1	2.0
35 X 48	4.1	6.6	5.8
48 X 65	7.9	11.1	10.0
65 X 100	11.9	14.9	13.8
100 X 200	21.9	24.5	23.4
200 X 325	12.7	17.5	13.4
-325	39.1	23.4	31.6
Sulfide	1.49	0.88	0.89
% Calcine Weight Change	-1.9	-3.8	-3.3
Elemental Analysis, Wt %			
SiO_2	19.90	24.38	22.16
SO_3	7.69	4.46	5.72
Na_2O	1.96	1.92	2.00
CaO	52.52	51.65	52.63
MgO	5.20	5.33	4.81
K_2O	0.43	0.44	0.47
P_2O_5	0.13	0.08	0.08
Al_2O_3	6.50	6.45	6.88
Fe_2O_3	2.35	2.62	2.65
TiO_2	0.15	0.16	0.17

Table 33-10. ASH AND ATTRITED ACCEPTOR COMPOSITES FOR RUN 33A

Date	2/9	← 2/10 →			← 2/11 →			← 2/12 →		
Time	1900	0300	1100	1900	0300	1100	1900	0300	1100	1900
Solids										
Feedstock	Char	← Velva Lignite →								
Feed Rate, lb/hr[1]	1,260	2,190	2,710	2,290	2,290	2,210	2,210	2,210	2,210	2,380
Recovered Overhead Solids, lb/hr[2]	-	190	245	190	175	135	105	100	105	130
Solids to Organic Pond, lb/hr[2]	55	60	95	70	55	50	40	30	20	30
Reject Acceptor, lb/hr	0	0	0	0	0	0	0	0	0	0
Char Withdrawal, lb/hr	0	0	0	0	0	0	0	0	0	0
Gas Flows[3]										
Boot Recycle, MSCFH	19.6	19.1	17.3	11.0	8.7	7.9	9.1	9.1	7.1	0
Boot Steam, MSCFH	20.3	21.3	24.3	31.3	32.8	33.0	31.4	32.4	32.8	40.2
Boot CO_2, MSCFH	0	0	0	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Side Steam, MSCFH	31.9	32.1	30.7	26.4	24.1	20.3	20.4	20.3	17.6	17.5
Side Air, MSCFH	19.3	19.6	19.2	11.1	8.5	6.4	4.3	2.6	0	0
Recycle Purge, MSCFH	2.2	2.3	2.4	2.5	2.7	2.7	2.8	2.9	3.0	3.0
Inert Purge, MSCFH	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total Inlet, MSCFH	93.5	94.6	94.1	83.4	77.9	71.4	69.1	68.4	61.6	61.8
Vent, MSCFH	59.7	77.2	75.3	64.4	59.3	55.1	53.0	49.1	48.0	52.8
Bed Conditions										
Boot Velocity, ft/sec[4]	2.1	2.1	2.2	2.3	2.2	2.2	2.2	2.2	2.2	2.2
Char Bed Velocity, ft/sec[4]	1.0	1.0	1.0	0.9	0.8	0.7	0.7	0.7	0.6	0.6
Boot Density, lb/ft^3[5]	101	101	99	99	95	92	87	86	81	77
Char Bed Density, lb/ft^3[5]	42	37	37	30	30	30	29	30	32	35
Char Bed Height, ft[5]	25.0	22.4	23.2	23.2	25.0	25.8	24.6	24.8	25.6	23.0
Average Boot Temperature, °F	1465	1500	1500	1500	1500	1500	1495	1500	1500	1490
Average Bed Temperature, °F	1470	1500	1495	1505	1500	1490	1490	1495	1505	1495
Overhead Gas Compositions, Dry Mol %										
CO	9.9	18.4	18.0	16.3	15.9	15.4	15.0	14.8	14.8	14.7
CO_2	19.6	15.1	14.2	13.9	11.9	11.3	10.7	8.8	9.8	9.8
N_2	41.7	25.3	22.1	16.6	13.9	11.6	9.1	7.6	4.1	3.9
H_2	24.5	35.1	38.3	44.8	49.0	51.4	53.8	58.9	59.3	59.4
CH_4	4.1	6.0	7.3	8.3	9.2	10.2	11.3	11.9	12.0	12.2

(1) Determined by feeder RPM measurements; for char, lb/hr = 420*RPM; for lignite, lb/hr = 417*RPM
(2) Averaged during the period 2/14 0300 to 2/21 0300
(3) Determined by orifice flow meter measurements
(4) Based on inlet gas flow rates
(5) Indicated by pressure tap measurements

Table 33-11. GASIFIER DATA FOR RUN 33B (Sheet 1 of 3)

Date	← 2/13 →			← 2/14 →			← 2/15 →			← 2/16 →		
Time	0300	1100	1900	0300	1100	1900	0300	1100	1900	0300	1100	1900
Solids												
Feedstock	← Velva Lignite →											
Feed Rate, lb/hr[1]	2,500	2,500	2,710	2,500	2,590	2,590	2,590	2,670	2,670	2,710	2,710	2,710
Recovered Overhead Solids, lb/hr[2]	150	-	160	120	120	120	120	120	120	120	120	120
Solids to Organic Pond, lb/hr[2]	40	50	35	35	35	35	35	35	35	35	35	35
Reject Acceptor, lb/hr	0	0	0	0	0	0	0	0	0	0	0	0
Char Withdrawal, lb/hr	0	0	0	0	0	0	0	0	0	0	0	0
Gas Flows[3]												
Boot Recycle, MSCFH	0	0	0	0	0	0	0	0	0	0	0	0
Boot Steam, MSCFH	41.1	40.1	40.9	41.2	40.9	39.9	41.0	40.6	41.5	41.0	41.5	41.1
Boot CO_2, MSCFH	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Side Steam, MSCFH	17.5	17.5	18.9	16.6	15.9	15.8	15.7	15.7	15.6	15.7	15.7	15.7
Side Air, MSCFH	0	0	0	0	0	0	0	0	0	0	0	0
Recycle Purge, MSCFH	3.0	2.9	3.0	3.0	3.0	2.9	3.0	3.0	3.0	3.0	3.0	3.0
Inert Purge, MSCFH	0.2	0.1	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.2
Total Inlet, MSCFH	62.7	61.5	63.9	61.9	61.0	59.8	60.9	60.4	61.2	60.8	61.4	60.9
Vent, MSCFH	54.7	52.2	51.6	52.7	53.9	53.9	52.4	53.9	54.1	54.2	53.5	53.6
Bed Conditions												
Boot Velocity, ft/sec[4]	2.2	2.1	2.2	2.2	2.2	2.1	2.2	2.2	2.2	2.2	2.2	2.2
Char Bed Velocity, ft/sec[4]	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Boot Density, lb/ft^3[5]	74	72	71	68	66	65	65	65	65	65	65	65
Char Bed Density, lb/ft^3[5]	33	34	35	34	32	33	33	33	33	32	32	33
Char Bed Height, ft[5]	23.2	24.0	21.0	24.0	25.0	26.6	26.0	26.8	26.0	26.0	25.2	24.8
Average Boot Temperature, °F	1485	1475	1470	1475	1475	1470	1475	1475	1475	1470	1475	1475
Average Bed Temperature, °F	1490	1495	1485	1485	1490	1490	1490	1485	1485	1490	1495	1495
Overhead Gas Compositions, Dry Mol %												
CO	14.2	13.8	13.8	13.7	14.1	13.6	13.8	14.0	13.7	13.8	13.8	14.2
CO_2	10.9	10.4	10.1	10.0	9.7	10.7	10.7	10.3	10.1	10.1	10.1	9.8
N_2	3.5	3.7	3.1	3.3	3.1	3.9	3.3	3.0	3.7	3.4	3.3	3.9
H_2	58.7	59.1	59.2	59.4	60.2	59.2	59.2	59.5	59.4	59.5	59.5	59.1
CH_4	12.7	13.0	13.7	13.6	12.9	12.6	13.0	13.2	13.1	13.2	13.3	13.0

(1) Determined by feeder RPM measurements; for char, lb/hr = 420*RPM; for lignite, lb/hr = 417*RPM
(2) Averaged during the perios 2/14 0300 to 2/21 0300
(3) Determined by orifice flow meter measurements
(4) Based on inlet gas flow rates
(5) Indicated by pressure tap measurements

Table 33-11. GASIFIER DATA FOR RUN 33B (Sheet 2 of 3)

Date	← 2/17 →			← 2/18 →			← 2/19 →			← 2/20 →			2/21
Time	0300	1100	1900	0300	1100	1900	0300	1100	1900	0300	1100	1900	0300
Solids													
Feedstock	← Velva Lignite →												
Feed Rate, lb/hr[1]	2,710	2,710	2,710	2,710	2,710	2,710	2,710	2,710	2,710	2,710	2,710	2,710	2,710
Recovered Overhead Solids, lb/hr[2]	120	120	120	120	120	120	120	120	120	120	120	120	120
Solids to Organic Pond, lb/hr[2]	35	35	35	35	35	35	35	35	35	35	35	35	35
Reject Acceptor, lb/hr	0	0	0	0	0	0	0	0	0	0	0	0	0
Char Withdrawal, lb/hr	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Flows[3]													
Boot Recycle, MSCFH	0	0	0	0	0	0	0	0	0	0	0	0	0
Boot Steam, MSCFH	41.2	41.1	40.8	41.1	41.4	41.5	41.2	41.0	41.2	40.6	40.7	40.6	40.9
Boot CO_2, MSCFH	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.7	0.8	0.9	0.9
Side Steam, MSCFH	15.8	15.9	16.0	15.7	15.7	15.8	15.8	15.7	15.7	15.5	15.6	15.6	15.7
Side Air, MSCFH	0	0	0	0	0	0	0	0	0	0	0	0	0
Recycle Purge, MSCFH	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.8
Inert Purge, MSCFH	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
Total Inlet, MSCFH	61.2	61.1	60.9	60.9	61.2	61.4	61.1	60.8	60.8	60.0	60.3	60.3	60.6
Vent, MSCFH	54.5	55.4	54.3	53.5	52.6	53.8	53.8	53.3	53.6	54.7	52.5	53.8	51.3
Bed Conditions													
Boot Velocity, ft/sec[4]	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Char Bed Velocity, ft/sec[4]	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Boot Density, lb/ft^3[5]	65	66	68	66	68	68	68	68	69	69	69	69	68
Char Bed Density, lb/ft^3[5]	34	35	34	35	36	36	37	36	35	34	32	31	32
Char Bed Height, ft[5]	24.0	24.2	24.2	22.6	23.2	21.6	20.8	20.2	22.0	24.6	25.2	26.2	24.6
Average Boot Temperature, °F	1480	1485	1475	1470	1480	1475	1475	1475	1470	1470	1475	1480	1480
Average Bed Temperature, °F	1495	1505	1490	1490	1495	1495	1490	1490	1490	1490	1495	1500	1495
Overhead Gas Compositions, Dry Mol %													
CO	14.1	14.9	13.7	13.7	13.6	13.8	13.3	14.0	14.4	14.4	14.2	14.7	13.9
CO_2	9.0	9.2	9.6	10.7	11.0	10.0	10.0	9.3	9.5	9.7	10.1	9.3	10.6
N_2	3.2	3.4	3.4	3.4	3.4	3.1	4.3	3.9	3.2	4.0	4.3	3.6	4.2
H_2	60.4	59.8	59.8	58.7	58.9	59.8	59.0	59.4	59.1	58.7	58.6	59.5	58.9
CH_4	13.4	12.7	13.5	13.4	13.0	13.3	13.3	13.2	13.7	13.1	12.8	12.9	12.4

(1) Determined by feeder RPM measurements; for char, lb/hr = 420*RPM; for lignite, lb/hr = 417*RPM
(2) Averaged during the period 2/14 0300 to 2/21 0300
(3) Determined by orifice flow meter measurements
(4) Based on inlet gas flow rates
(5) Indicated by pressure tap measurements

Table 33-11. GASIFIER DATA FOR RUN 33B (Sheet 3 of 3)

Date	2/9	← 2/10 →			← 2/11 →			← 2/12 →		
Time	1900	0300	1100	1900	0300	1100	1900	0300	1100	1900
Solids	Dead-Burned									
Acceptor Feedstock	Dolomite	← Minnekahta Limestone →								
Acceptor Makeup Rate, lb/hr[1]	280	280	560	560	560	560	560	560	560	560
Auxiliary Fuel Char, lb/hr[1]	225	155	190	310	260	260	240	225	210	190
Acceptor Circulation, lb/hr[2]	8,800	14,800	14,700	13,000	12,400	12,100	11,100	11,500	13,400	13,000
Reject Acceptor, lb/hr[3]	325	325	475	330	420	450	365	400	310	470
Ash and Attrited Acceptor, lb/hr[3]	-	-	-	-	-	-	-	-	-	155
Gas Flows[4]										
Acceptor Lift Recycle, MSCFH	56.7	57.6	56.5	55.9	56.5	55.7	55.4	56.2	55.5	55.4
Char Lift, MSCFH[5]	10.0	10.0	10.1	10.1	10.1	10.1	10.0	10.1	10.0	10.1
Recycle to Air Line, MSCFH	41.9	22.1	20.7	0	0	0	0	0	0	0
Air, MSCFH	67.9	56.3	71.0	71.2	78.3	76.5	77.1	81.6	81.5	86.8
Recycle Purge, MSCFH	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	2.0
Nitrogen Purge, MSCFH	1.9	2.0	1.7	1.8	1.8	1.7	1.6	1.7	1.4	1.3
Total Inlet, MSCFH	180.4	150.0	162.0	141.0	148.7	146.0	146.1	151.6	150.3	155.6
Vent to Elliott Test Fixture, MSCFH	0	0	0	0	0	0	0	0	0	0
Total Vent, MSCFH	84.2	68.7	88.7	92.4	98.4	101.5	104.0	110.1	106.8	104.3
Bed Conditions										
Gas Velocity, ft/sec[6]	3.3	2.7	3.0	2.6	2.7	2.7	2.6	2.8	2.8	2.8
Bed Density, lb/ft^3[7]	96	98	103	97	90	87	86	80	75	73
Bed Height, ft[7]	19.5	19.7	20.0	20.2	19.7	20.0	19.7	19.8	19.8	19.8
Average Bed Temperature, °F	1870	1845	1845	1855	1840	1840	1830	1855	1855	1840
Overhead Gas Compositions, Dry Mol %										
O_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	4.3	3.9	4.1	4.0	4.4	3.5	3.5	4.1	0.8	1.5
CO_2	17.8	16.7	22.5	22.3	23.4	26.0	26.2	26.9	27.1	27.0
N_2	77.9	79.4	73.4	73.7	72.2	70.5	70.3	69.0	72.1	71.5

(1) Determined by feeder RPM measurements: for acceptor, lb/hr = 280*RPM; for auxiliary fuel, lb/hr = RPM*(279-66.8*RPM)
(2) Determined by lift line pressure drop measurements
(3) Averaged during the period 2/14 0300 to 2/21 0300
(4) Determined by orifice flow meter measurements
(5) Char lift is approximately 7.0 MSCFH inert gas and the remainder recycle
(6) Based on inlet gas flow rates
(7) Indicated by pressure tap measurements

Table 33-12. REGENERATOR DATA FOR RUN 33B (Sheet 1 of 3)

Date	2/13			2/14			2/15			2/16		
Time	0300	1100	1900	0300	1100	1900	0300	1100	1900	0300	1100	1900
Solids												
Acceptor Feedstock	Minnekahta Limestone											
Acceptor Makeup Rate, lb/hr[1]	560	560	560	560	560	560	560	560	560	560	560	560
Auxiliary Fuel Char, lb/hr[1]	190	0	110	175	130	95	95	50	45	65	45	45
Acceptor Circulation, lb/hr[2]	12,300	12,000	14,500	12,600	12,000	12,900	13,000	12,300	13,000	12,300	12,000	11,700
Reject Acceptor, lb/hr[3]	425	340	340	340	340	340	340	340	340	340	340	340
Ash and Attrited Acceptor, lb/hr[3]	155	155	155	155	155	155	155	155	155	155	155	155
Gas Flows[4]												
Acceptor Lift Recycle, MSCFH	54.7	55.0	55.1	55.4	55.6	55.3	55.8	55.1	55.5	55.4	55.1	55.2
Char Lift, MSCFH[5]	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Recycle to Air Line, MSCFH	0	0	0	0	0	0	0	0	0	0	0	0
Air, MSCFH	87.7	85.4	87.9	88.5	87.6	83.9	84.5	85.6	85.8	85.7	86.3	87.5
Recycle Purge, MSCFH	1.8	2.1	2.2	2.2	2.0	2.1	2.2	2.2	2.2	2.7	2.7	2.7
Nitrogen Purge, MSCFH	1.2	1.3	1.4	1.4	1.6	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Total Inlet, MSCFH	155.4	153.8	156.6	157.5	156.8	152.7	153.8	154.3	154.9	155.2	155.5	156.8
Vent to Elliott Test Fixture, MSCFH	0	0	0	0	0	0	0	0	10.0	9.1	10.5	10.6
Total Vent, MSCFH	113.9	112.0	108.4	112.5	113.2	110.3	109.8	109.8	110.3	107.6	110.5	111.6
Bed Conditions												
Gas Velocity, ft/sec[6]	2.9	2.8	2.8	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.9
Bed Density, lb/ft^3[7]	72	71	69	68	68	67	68	68	67	67	68	68
Bed Height, ft[7]	19.5	20.1	19.7	20.0	20.2	20.2	20.1	20.2	20.0	20.0	20.0	19.5
Average Bed Temperature, °F	1855	1850	1835	1845	1845	1835	1855	1835	1845	1830	1840	1860
Overhead Gas Compositions, Dry Mol %												
O_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	4.9	2.1	3.7	4.6	5.1	2.6	2.8	1.8	2.6	1.4	4.5	3.9
CO_2	26.3	26.4	26.1	24.7	25.3	26.8	27.2	27.3	28.5	27.9	27.5	26.6
N_2	68.8	71.5	70.2	70.7	69.6	70.6	70.0	70.9	68.9	70.7	68.0	69.5

(1) Determined by feeder RPM measurements: for acceptor, lb/hr = 280*RPM; for auxiliary fuel, lb/hr = RPM*(279-66.8*RPM)
(2) Determined by lift line pressure drop measurements
(3) Averaged during the period 2/14 0300 to 2/21 0300
(4) Determined by orifice flow meter measurements
(5) Char lift is approximately 7.0 MSCFH inert gas and the remainder recycle
(6) Based on inlet gas flow rates
(7) Indicated by pressure tap measurements

Table 33-12. REGENERATOR DATA FOR RUN 33B (Sheet 2 of 3)

Date	← 2/17 →			← 2/18 →			← 2/19 →			← 2/20 →			2/21
Time	0300	1100	1900	0300	1100	1900	0300	1100	1900	0300	1100	1900	0300
Solids													
Acceptor Feedstock	← Minnekahta Limestone →												
Acceptor Makeup Rate, lb/hr(1)	560	560	560	560	560	560	560	560	560	560	560	560	560
Auxiliary Fuel Char, lb/hr(1)	45	45	45	45	45	45	45	95	95	75	105	85	105
Acceptor Circulation, lb/hr(2)	12,700	12,700	13,000	12,900	12,300	14,200	13,600	12,900	11,700	12,000	12,900	13,300	12,900
Reject Acceptor, lb/hr(3)	340	340	340	340	340	340	340	340	340	340	340	340	340
Ash and Attrited Acceptor, lb/hr(3)	155	155	155	155	155	155	155	155	155	155	155	155	155
Gas Flows(4)													
Acceptor Lift Recycle, MSCFH	55.9	56.2	55.8	55.4	55.6	55.8	55.5	54.9	55.0	55.2	54.7	55.2	54.8
Char Lift, MSCFH(5)	10.1	10.0	10.0	10.0	10.0	10.1	10.1	10.0	10.0	10.0	10.0	10.0	10.1
Recycle to Air Line, MSCFH	0	0	0	0	0	0	0	0	0	0	0	0	0
Air, MSCFH	86.9	87.7	86.6	85.5	88.9	88.2	87.7	86.9	86.2	87.4	87.5	86.3	89.6
Recycle Purge, MSCFH	2.6	2.6	2.6	2.7	2.8	2.8	2.5	2.8	2.8	2.4	2.4	2.4	2.4
Nitrogen Purge, MSCFH	1.3	1.4	1.3	1.3	1.2	1.2	1.1	1.3	1.3	1.3	1.3	1.4	1.2
Total Inlet, MSCFH	156.8	157.9	156.3	154.9	158.5	158.1	157.0	155.9	155.3	156.3	155.9	155.3	158.1
Vent to Elliott Test Fixture, MSCFH	10.0	9.3	10.0	9.6	9.4	9.7	9.7	10.0	9.4	9.4	9.1	10.3	9.7
Total Vent, MSCFH	111.5	110.1	106.7	108.0	112.2	110.1	110.6	108.9	107.3	109.1	110.7	120.7	111.5
Bed Conditions													
Gas Velocity, ft/sec(6)	2.9	2.9	2.8	2.8	2.9	2.9	2.9	2.8	2.8	2.9	2.9	2.8	2.9
Bed Density, lb/ft3(7)	68	69	70	70	70	70	70	71	71	73	73	71	71
Bed Height, ft(7)	20.0	19.5	20.0	19.8	20.0	19.8	19.8	19.7	19.5	20.0	19.8	19.7	20.0
Average Bed Temperature, °F	1850	1850	1815	1835	1850	1835	1840	1845	1845	1850	1855	1835	1850
Overhead Gas Compositions, Dry Mol %													
O_2	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	4.2	-	4.2	2.4	3.0	2.9	2.6	3.4	3.3	3.7	3.6	3.4	2.7
CO_2	25.1	-	25.2	25.5	26.6	26.4	27.9	26.7	26.9	26.3	25.9	24.8	25.5
N_2	70.7	-	70.6	72.1	70.4	70.7	69.5	69.9	69.8	70.0	70.5	71.8	71.8

(1) Determined by feeder RPM measurements: for acceptor, lb/hr = 280*RPM; for auxiliary fuel, lb/hr = RPM*(279-66.8*RPM)
(2) Determined by lift line pressure drop measurements
(3) Averaged during the period 2/14 0300 to 2/21 0300
(4) Determined by orifice flow meter measurements
(5) Char lift is approximately 7.0 MSCFH inert gas and the remainder recycle
(6) Based on inlet gas flow rates
(7) Indicated by pressure tap measurements

Table 33-12. REGENERATOR DATA FOR RUN 33B (Sheet 3 of 3)

Date 2/5/76 - 2/23/76

Screen Size, Wt % Tyler Mesh	Acceptor: Dead-Burned Dolomite	Acceptor: Minnekahta Limestone	Screen Size, Wt % Tyler Mesh	Lignite: Husky Char	Lignite: Velva Lignite
+4			+6		
4 X 6	0.2	1.3	6 X 8	1.8	1.7
6 X 8	0.6	30.4	8 X 10	3.5	3.4
8 X 9	0.9	35.6	10 X 14	9.8	9.4
9 X 10	11.5	21.7	14 X 20	11.5	11.2
10 X 12	41.9	9.4	20 X 28	13.8	18.1
12 X 14	29.2	0.9	28 X 35	15.9	16.5
14 X 16	12.4	0.1	35 X 48	13.7	15.5
16 X 20	3.2	0.1	48 X 65	10.6	11.3
20 X 24	0.2	Tr	65 X 100	5.7	7.6
24 X 28	Tr	Tr	100 X 200	6.5	4.2
-28	Tr	0.5	-200	7.2	1.1
Calcine Weight Loss, %	0.5	42.7			
Ultimate Analysis, Wt %					
Moisture				1.0	0.3
C				71.7	66.0
H + Moisture H				2.2	4.2
N				0.7	0.8
S				1.59	0.51
Ash + SO_3				18.98	7.04
Elemental Analysis, Wt %					
SiO_2	1.66	3.75		46.89	22.92
SO_3	0.10	0.05		17.57	11.57
Na_2O	0.03	0.05		2.58	1.11
CaO	56.73	94.29		16.69	35.80
MgO	39.83	0.83		4.22	10.30
K_2O	0.01	0.05		0.43	0.19
P_2O_5	0.01	0.04		0.04	0.16
Al_2O_3	1.06	0.52		8.28	12.23
Fe_2O_3	0.52	0.42		3.30	5.48
TiO_2	0.05	0.00		Tr	0.24

Table 33-13. FEEDSTOCK COMPOSITES FOR RUN 33B

Date	2/9	← 2/10 →			← 2/11 →			← 2/12 →		
Time	1600	0000	0800	1600	0015	0800	1600	0000	0800	1600
Screen Size, Wt % Retained on Tyler Mesh										
4										
6						0.2			0.6	
8	0.3		0.9			4.4			12.8	
9	0.5	2.3	0.9	2.0	7.5	6.0	14.9	25.0	12.8	30.3
10	10.3		10.9			14.1			25.3	
12	37.8	59.5	38.4	57.3	48.0	28.2	49.6	48.6	20.9	47.2
14	32.0		30.0			22.7			14.8	
16	14.3		13.2			10.7			3.3	
20	3.3	38.9	3.1	37.6	38.1	2.7	26.9	20.2	1.8	14.1
24	0.9		0.8			4.0			2.0	
28	0.3	0.9	0.2	1.4	2.6	0.9	3.8	3.0	1.5	4.0
Pan	0.3	0.4	1.5	1.7	3.8	6.0	4.8	3.2	3.8	4.5
% Calcine Weight Change	-0.3		-0.3			-0.5			-0.2	
Elemental Analysis, Wt %										
S=	0.04		0.06			0.01			0.03	
SiO_2	2.81		3.79			5.00			6.60	
SO_3	0.24		0.25			0.19			0.35	

Table 33-14. CIRCULATING ACCEPTOR CALCINED ACCEPTOR TO GASIFIER FOR RUN 33B (Sheet 1 of 4)

Date	← 2/13 →			← 2/14 →			← 2/15 →			2/16
Time	0000	0800	1600	0000	0800	1600	0000	0800	1600	0000
Screen Size, Wt % Retained on Tyler Mesh										
4										
6		1.6			2.3			3.1		
8		22.0			24.0			21.0		
9	36.3	22.7	48.6	47.4	23.4	58.5	59.6	36.7	81.1	58.2
10		23.8			20.9			15.2		
12	42.1	12.5	35.0	34.1	10.7	28.6	27.6	7.2	10.0	27.0
14		5.4			5.5			4.6		
16		1.9			2.2			2.0		
20	11.7	2.1	7.9	8.9	2.1	6.8	6.6	1.9	4.2	7.7
24		2.6			2.4			2.1		
28	5.7	1.7	4.7	4.8	1.1	3.2	3.3	1.6	2.3	3.6
Pan	4.3	3.6	3.7	4.9	5.3	2.9	2.9	4.6	2.3	3.6
% Calcine Weight Change		-0.1			-1.8			-1.0		
Elemental Analysis, Wt %										
S=		0.04			0.02			0.05		
SiO_2		7.63			8.78			8.11		
SO_3		0.42			0.30			0.26		

Table 33-14. CIRCULATING ACCEPTOR CALCINED ACCEPTOR TO GASIFIER FOR RUN 33B (Sheet 2 of 4)

Date	2/16		← 2/17 →			← 2/18 →			2/19
Time	0800	1600	0020	0800	1600	0000	0800	1600	0000	0800
Screen Size, Wt % Retained on Tyler Mesh										
4										
6	6.0			6.5			7.0			9.2
8	33.8			32.6			29.1			34.7
9	23.7	62.8	67.5	21.8	56.0	59.5	18.0	62.7	62.0	19.2
10	16.6			15.9			15.7			15.2
12	8.0	24.7	22.1	8.0	25.3	23.5	8.9	24.3	23.1	8.2
14	4.5			4.8			5.6			4.8
16	1.6			1.8			2.5			1.8
20	1.2	7.2	5.7	1.5	8.8	7.5	2.0	7.2	6.8	1.3
24	1.4			1.7			2.2			1.2
28	0.7	2.7	2.2	0.9	4.6	4.0	1.2	2.6	3.4	0.6
Pan	2.4	2.6	2.6	4.5	5.3	5.4	7.9	3.2	4.8	3.8
% Calcine Weight Change	-1.1			-1.8			-1.2			-0.4
Elemental Analysis, Wt %										
S=	0.02			0.02			0.02			0.05
SiO_2	5.07			6.73			7.12			9.52
SO_3	0.27			0.21			0.09			0.15

Table 33-14. CIRCULATING ACCEPTOR CALCINED ACCEPTOR TO GASIFIER FOR RUN 33B (Sheet 3 of 4)

Date	2/19	← 2/20 →			← 2/21 →		
Time	1600	0000	0800	1600	0000	0800	1600
Screen Size, Wt % Retained on Tyler Mesh							
4							
6			5.9			7.7	
8			27.8			26.2	
9	60.6	51.5	19.8	56.8	62.3	17.6	66.3
10			17.8			14.1	
12	24.3	23.0	8.7	23.8	21.3	7.9	20.2
14			5.2			5.0	
16			2.4			2.4	
20	7.6	10.4	2.2	8.3	6.5	2.4	6.0
24			2.3			2.8	
28	3.3	5.8	1.1	4.2	3.9	2.0	3.0
Pan	4.3	9.3	6.8	6.9	6.0	12.0	4.4
% Calcine Weight Change			-1.3				
Elemental Analysis, Wt %							
S=			0.04				
SiO_2			7.71				
SO_2			0.15				

Table 33-14. CIRCULATING ACCEPTOR CALCINED ACCEPTOR TO GASIFIER FOR RUN 33B (Sheet 4 of 4)

Date	2/9		← 2/10 →			← 2/11 →			2/12
Time	0800	1600	0000	0800	1600	0000	0800	1600	0000	0800
Screen Size, Wt % Retained on Tyler Mesh										
4										
6							0.3			1.0
8	0.6			0.6			5.1			12.6
9	0.5	0.9	1.0	0.5	4.0	8.8	7.8	16.9	19.4	16.1
10	6.2			7.4			17.8			18.1
12	34.5	49.4	50.4	33.0	47.7	51.1	29.6	54.0	52.9	24.7
14	33.0			32.3			23.5			16.7
16	18.4			18.1			10.2			4.2
20	5.5	47.8	47.3	5.0	45.5	38.9	2.8	27.6	23.1	2.0
24	0.8			1.2			1.2			1.7
28	Tr	1.3	1.3	0.3	1.7	1.0	0.1	1.3	2.9	0.6
Pan	0.6	0.5	Tr	1.6	1.1	0.2	1.6	0.3	1.6	2.1
Particle Density, lb/cu ft					190		177			127
% Calcine Weight Change	-1.1			-1.0			-5.2			-7.5
Activity	0.01			0.01	0.03		0.8			0.12
Elemental Analysis, Wt %										
S=	0.01			0.07			0.02			0.06
SiO_2	0.80			2.50			4.25			5.61
SO_3	0.09			0.54			0.14			0.28

Table 33-15. CIRCULATING ACCEPTOR RECARBONATED ACCEPTOR FROM GASIFIER FOR RUN 33B (Sheet 1 of 4)

Date	2/12	← 2/13 →			← 2/14 →				2/15	
Time	1600	0000	0800	1600	0000	0800	1600	2300	0750	1600
Screen Size, Wt % Retained on Tyler Mesh										
4										
6			1.2			1.5			2.1	
8			20.2			27.7			27.0	
9	33.8	37.6	23.3	23.5	50.3	27.2	56.9	55.8	25.3	57.7
10			26.9			21.8			19.2	
12	49.6	46.2	15.0	62.5	38.0	10.3	29.8	30.0	10.0	28.7
14			7.2			4.8			5.6	
16			2.3			2.0			2.7	
20	13.4	12.8	1.4	11.1	9.1	1.7	8.4	9.5	2.4	8.9
24			1.3			1.3			2.0	
28	2.2	2.4	0.2	2.1	2.1	0.6	3.0	3.2	0.9	3.3
Pan	1.0	1.0	0.9	0.9	0.6	1.1	1.9	1.5	2.8	1.4
Particle Density, lb/cu ft			143	133	117	135	132	128	125	118
% Calcine Weight Change			-8.5			-9.1			-8.9	
Activity	0.09	0.09	0.11	0.11	0.13	0.13	0.13	0.16	0.13	0.11
Elemental Analysis, Wt %										
S=			0.07			0.05			0.06	
SiO_2			5.95			5.73			5.90	
SO_3			0.38			0.39			0.27	

Table 33-15. CIRCULATING ACCEPTOR RECARBONATED ACCEPTOR FROM GASIFIER FOR RUN 33B (Sheet 2 of 4)

Date	← 2/16 →			← 2/17 →			← 2/18 →			2/19
Time	0000	0800	1600	0000	0800	1600	0000	0800	1630	0000
Screen Size, Wt % Retained on Tyler Mesh										
4										
6		3.2			4.1			4.7		
8		32.6			32.5			33.8		
9	60.6	25.9	54.8	64.6	22.8	56.7	62.2	22.1	63.0	59.8
10		16.5			16.2			14.9		
12	26.4	8.5	27.6	24.5	8.3	26.3	23.2	7.2	25.2	23.6
14		4.9			5.0			4.7		
16		2.3			2.5			2.3		
20	8.9	1.8	10.9	8.1	2.1	10.2	9.5	1.6	8.6	10.4
24		1.7			2.1			5.5		
28	2.8	0.7	3.8	1.9	0.9	3.7	3.4	0.6	2.3	3.9
Pan	1.2	1.9	2.8	0.9	3.6	3.1	1.7	2.6	0.9	2.4
Particle Density, lb/cu ft	122	126	122	119	121	125	124	128	126	126
% Calcine Weight Change		-9.3			-9.3			-8.4		
Activity	0.12	0.11	0.12	0.11	0.12	0.10	0.12	0.12	0.10	0.10
Elemental Analysis, Wt %										
S=		0.03						0.05		
SiO_2		6.56						6.68		
SO_3		0.21						0.35		

Table 33-15. CIRCULATING ACCEPTOR RECARBONATED ACCEPTOR FROM GASIFIER FOR RUN 33B (Sheet 3 of 4)

Date	2/19		← 2/20 →			← 2/21 →		
Time	0800	1600	0000	0800	1600	0000	0800	1600
Screen Size, Wt % Retained on Tyler Mesh								
4								
6	3.9			4.9			6.0	
8	27.4			30.6			30.6	
9	20.5	60.1	73.6	21.9	62.8	58.1	21.8	62.4
10	16.8			17.5			15.0	
12	9.9	26.3	3.3	9.1	25.6	24.2	9.0	24.6
14	6.7			5.9			6.4	
16	3.8			3.4			3.2	
20	3.6	9.6	12.4	2.1	8.3	10.6	2.5	9.0
24	2.8			1.7			2.1	
28	0.8	2.7	3.7	0.5	2.3	4.0	0.5	2.6
Pan	3.8	1.3	2.0	2.4	1.1	3.1	2.9	1.4
Particle Density, lb/cu ft	128	127	127	127	127	127	130	127
% Calcine Weight Change	-8.6			-8.8			-9.0	
Activity	0.12	0.10	0.10	0.11	0.11	0.12	0.11	0.09
Elemental Analysis, Wt %								
S=	0.03			0.04			0.06	
SiO_2	8.28			7.71			7.43	
SO_3	0.20			0.15			0.20	

Table 33-15. CIRCULATING ACCEPTOR RECARBONATED ACCEPTOR FROM GASIFIER FOR RUN 33B (Sheet 4 of 4)

Date	← 2/9 →		← 2/10 →				← 2/11 →			← 2/12 →	
Time	0500	1600	0100	0915	1705	2325	0600	1040	1710	0100	0800
Screen Size, Wt %											
Retained on Tyler Mesh											
4											
6		Tr		0.2			0.1				0.2
8		1.8		0.7			2.6				7.2
9	0.5	2.0	0.5	0.8	1.8	1.5	5.7	17.6	24.7	13.1	13.1
10		13.5		10.0			16.8				35.0
12	49.8	41.9	53.8	35.9	38.3	50.5	36.3	51.8	51.4	60.9	24.8
14		25.0		31.7			26.8				14.4
16		12.1		15.1			10.3				2.9
20	49.1	3.2	45.2	4.6	59.3	46.2	2.4	28.9	21.9	24.2	1.1
24		0.5		0.6			0.6				0.8
28	0.6	Tr	0.6	0.2	0.7	1.2	0.1	1.3	1.4	1.2	0.1
Pan	Tr	Tr	Tr	0.4	Tr	0.6	0.3	0.5	0.6	0.5	0.7
% Calcine Weight Change		-0.9		0.0			-2.9				-0.1
Elemental Analysis, Wt %											
S		0.02		0.06			0.03				0.01
SiO_2		1.04		2.44			3.17				4.72
SO_3		0.13		0.39			0.13				0.31

Table 33-16. REJECT ACCEPTOR WITHDRAWAL FOR RUN 33B (Sheet 1 of 4)

Date	2/12		2/13				2/14			2/15	
Time	1610	2130	0340	1100	1710	2330	0600	1300	1830	0105	0800
Screen Size, Wt %											
Retained on Tyler Mesh											
4											
6				0.2			0.3				3.6
8				11.6			18.6				26.1
9	26.1	26.0	38.7	22.3	41.5	54.8	27.5	55.6	60.8	59.5	26.3
10				32.9			26.0				20.3
12	52.2	58.9	45.0	17.8	46.1	34.4	13.1	32.7	30.8	30.1	10.3
14				8.1			6.3				5.7
16				2.4			2.5				2.4
20	17.9	12.7	12.4	1.4	8.3	7.2	1.7	8.5	6.4	7.0	1.9
24				1.3			1.5				1.6
28	2.2	1.5	2.3	0.5	2.3	2.1	0.7	2.1	1.4	2.0	0.9
Pan	1.6	0.8	1.6	1.5	1.8	1.6	1.8	1.0	0.7	1.4	0.7
% Calcine Weight Change				-0.8			-0.3				-0.6
Elemental Analysis, Wt %											
S				0.02			0.01				0.01
SiO_2				6.36			6.69				5.36
SO_3				0.35			0.25				0.16

Table 33-16. REJECT ACCEPTOR WITHDRAWAL FOR RUN 33B (Sheet 2 of 4)

Date	← 2/15 →		← 2/16 →			← 2/17 →			← 2/18 →	
Time	1420	2015	0330	1000	1640	0020	0800	1535	2150	0510	1330
Screen Size, Wt % Retained on Tyler Mesh											
4											
6				1.6			2.6			1.3	
8				31.9			37.1			23.0	
9	58.9	63.9	61.1	28.2	37.4	63.8	28.5	62.2	53.6	25.3	60.8
10				18.6			18.1			20.7	
12	30.4	26.8	28.2	8.2	38.4	25.8	7.6	26.8	33.5	11.4	26.6
14				4.8			3.5			6.7	
16				2.2			1.0			3.1	
20	8.8	6.5	7.0	1.1	15.8	6.8	0.5	7.0	9.7	2.2	8.8
24				1.3			0.8			1.9	
28	1.7	1.6	2.0	0.1	4.6	1.9	Tr	2.1	1.8	0.9	2.2
Pan	0.2	1.2	1.6	2.0	3.8	1.6	0.3	2.0	1.3	3.7	1.6
% Calcine Weight Change				-0.4			-1.7			-0.1	
Elemental Analysis, Wt %											
S				0.02			0.01			0.03	
SiO_2				7.97			5.28			5.16	
SO_3				0.10			0.12			0.23	

Table 33-16. REJECT ACCEPTOR WITHDRAWAL FOR RUN 33B (Sheet 3 of 4)

Date	2/18	← 2/19 →			← 2/20 →				← 2/21 →	
Time	1940	0250	0900	1730	0055	0735	1515	2240	0600	1210
Screen Size, Wt % Retained on Tyler Mesh										
4										
6			3.1			9.1			7.2	
8			31.3			39.0			34.8	
9	67.5	54.9	25.3	66.6	48.2	22.3	61.6	62.0	21.0	54.1
10			19.1			14.4			16.4	
12	24.6	29.4	9.4	22.8	31.0	7.8	28.0	26.4	8.6	29.8
14			5.7			4.3			5.5	
16			2.4			1.7			2.4	
20	5.5	10.2	1.3	6.7	13.1	0.5	7.3	7.4	1.4	11.3
24			1.4			0.6			1.2	
28	1.4	2.8	Tr	2.0	3.9	0.1	1.8	2.3	0.3	2.8
Pan	1.0	2.7	1.0	1.9	3.8	0.1	1.4	2.0	1.3	2.1
% Calcine Weight Change			-0.4			-1.4			-1.4	
Elemental Analysis, Wt %										
S			0.01			0.03			0.02	
SiO_2			8.64			5.99			5.86	
SO_3			0.09			0.15			0.11	

Table 33-16. REJECT ACCEPTOR WITHDRAWAL FOR RUN 33B (Sheet 4 of 4)

Date	2/10		2/10		2/11		2/11		2/11		2/12	
Time	1200		2115		0400		1200		2030		0400	
Sample Portion	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total	Acceptor
Screen Size, Wt % Retained on Tyler Mesh												
8	0.7	2.8	1.3	2.1	1.7	6.0	2.2	6.5	2.4	6.4	4.6	8.8
9		1.9		3.9		6.0		7.2		12.3		12.8
10	3.0		7.2		5.1		6.5		8.6		12.1	
12		33.0		36.3		35.4		40.9		34.7		42.6
14	31.5	17.5	27.3	17.2	25.0	17.9	23.0	13.1	19.0	10.3	20.9	10.6
20	14.5	16.7	11.3	16.2	10.2	13.8	8.7	9.4	9.5	8.3	7.8	5.8
28	7.5	5.1	6.6	5.5	8.0	4.1	8.6	4.6	12.0	5.9	9.8	4.9
35	10.6		10.4		11.4		11.6		14.1		10.8	
48	13.4		13.5		14.5		15.4		15.7		11.7	
65	9.2	15.1	10.6	16.5	10.5	13.9	10.9	17.6	10.0	21.0	9.7	14.2
80		2.3		1.5		1.5		0.7		0.9		0
100	6.4		7.2		7.8		8.4		6.6		7.7	
200	3.0		3.2		4.2		4.0		1.8		3.8	
Pan	0.2	5.6	1.4	0.8	1.6	1.4	0.7	Tr	0.3	0.2	1.1	0.3
Acceptor, Wt %	48.8		42.0		51.6		39.9		42.5		54.3	
Ash + SO_3, Wt % in Char	8.6		13.0		16.3		16.0		13.2		16.9	
Ash Elemental Analysis, Wt %												
SiO_2	17.33						17.12					
SO_3	1.48						1.96					
Na_2O	2.52						1.78					

Table 33-17. GASIFIER CHAR BED MATERIAL FOR RUN 33B (Sheet 1 of 6)

Date	2/12		2/12		2/13		2/13		2/13		2/14	
Time	1200		2000		0400		1150		2000		0400	
Sample Portion	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total	Acceptor
Screen Size, Wt % Retained on Tyler Mesh												
8	5.1	12.8	7.6	18.7	8.0	23.4	7.7	13.7	10.1	23.8	10.8	23.3
9		18.2		18.7		19.7		13.7		22.6		20.9
10	13.7		16.3		18.0		18.8		18.3		20.2	
12		28.3		25.3		29.2		27.5		23.8		23.3
14	17.9	8.2	18.0	5.3		5.1	12.7	5.9	12.6	3.6	12.2	4.7
20	6.3	7.6	6.8	6.7	25.7	5.8	5.9	9.8	6.1	6.0	6.3	7.0
28	8.4	6.9	9.0	6.7	8.0	5.1	8.4	7.8	8.7	6.0	8.1	7.0
35	10.6		11.2		9.7		10.8		11.0		10.1	
48	13.2		12.8		12.5		13.0		13.6		12.8	
65	9.6	17.8	8.6	18.7	8.2	11.7	9.5	21.6	9.5	14.3	8.9	14.0
80		0.2		Tr				Tr		Tr		Tr
100	7.6		6.4		6.4		7.5		7.4		7.4	
200	4.6		2.5		2.5		4.6		2.6		3.3	
Pan	3.0	0	0.6	Tr	0.9	0	2.0	Tr	Tr	Tr	Tr	Tr
Acceptor, Wt %	37.7		42.3		54.3		39.5		46.8		45.5	
Ash + SO_3, Wt % in Char	15.6		10.0		13.1		12.9		14.3		14.3	
Ash Elemental Analysis, Wt %												
SiO_2	17.40						18.26					
SO_3	2.47						2.83					
Na_2O	1.56						1.37					

Table 33-17. GASIFIER CHAR BED MATERIAL FOR RUN 33B (Sheet 2 of 6)

Date	2/14		2/14		2/15		2/15		2/15		2/16	
Time	1200		2000		0400		1200		2015		0400	
Sample Portion	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total	Acceptor
Screen Size, Wt % Retained on Tyler Mesh												
8	7.6	16.5	11.8	29.4	13.3	26.5	9.9	23.8	14.6	29.9	9.9	28.0
9		23.7		23.0		24.5		19.0		19.4		20.0
10	14.8		17.4		17.2		14.8		17.3		14.6	
12		24.7		20.6		20.4		19.0		19.5		20.0
14	9.5	4.1	10.7	3.2	11.2	2.0	9.3	2.4	10.2	2.9	9.2	2.0
20	5.5	7.2	6.5	5.6	7.0	6.1	7.1	7.1	5.2	5.4	6.3	6.0
28	8.3	6.2	9.1	4.8	9.4	6.1	10.7	9.5	8.9	5.6	9.0	6.0
35	12.1		11.1		11.2		13.6		11.3		11.8	
48	15.3		13.3		12.3		14.7		13.4		14.3	
65	11.7	17.5	9.3	13.5	8.5	14.3	9.6	19.0	9.6	16.4	10.7	18.0
80		Tr		Tr		Tr		Tr		0.5		Tr
100	9.3		7.5		6.6		7.0		7.2		8.9	
200	4.5		2.9		3.0		2.7		2.0		4.3	
Pan	1.4	Tr	0.4	Tr	0.3	Tr	0.7	Tr	0.1	0.5	1.0	Tr
Acceptor, Wt %	46.0		47.8		46.6				51.3		41.5	
Ash + SO_3, Wt % in Char	14.92		14.33		14.46		12.77		12.73		14.30	
Ash Elemental Analysis, Wt %												
SiO_2	10.39						17.13					
SO_3	1.00						3.50					
Na_2O	1.07						1.79					

Table 33-17. GASIFIER CHAR BED MATERIAL FOR RUN 33B (Sheet 3 of 6)

Date	2/16		2/16		2/17		2/17		2/17		2/18	
Time	1200		2015		0400		1200		2030		0400	
Sample Portion	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total	Acceptor
Screen Size, Wt % Retained on Tyler Mesh												
8	11.4	28.0	11.5	25.0	16.2	28.2	14.4	36.3	16.9	33.5	16.9	30.9
9		18.0		17.2		20.5		20.0		18.0		19.6
10	14.6		15.0		17.5		16.3		15.8		17.3	
12		22.0		20.7		20.5		20.0		18.8		21.5
14	9.4	4.0	10.6	4.3	10.4	2.6	9.9	2.5	10.0	3.9	10.3	3.7
20	7.0	6.0	7.2	6.9	6.8	7.7	7.0	5.0	6.4	5.5	5.9	6.5
28	9.6	6.0	9.7	6.9	8.7	5.1	9.1	5.0	8.5	5.5	7.6	4.7
35	11.7		11.8		10.5		10.5		10.7		10.0	
48	13.5		14.0		12.2		12.2		12.8		12.3	
65	10.4	16.0	9.6	17.2	8.5	15.4	9.5	11.2	9.1	14.8	8.9	13.1
80		Tr		0.9		Tr						
100	8.0		7.3		6.5		7.4		7.5		7.2	
200	3.4		2.7		2.6		2.8		2.1		2.7	
Pan	1.0	Tr	0.7	0.9	Tr	Tr	0.9	Tr	0.3	Tr	0.9	Tr
Acceptor, Wt %	46.1		51.4		46.5		41.4		51.8		50.9	
Ash + SO_3, Wt % in Char	14.75		12.61		14.98		12.87		12.86		13.92	
Ash Elemental Analysis, Wt %												
SiO_2	18.60						14.92					
SO_3	1.49						2.38					
Na_2O	1.91						1.54					

Table 33-17. GASIFIER CHAR BED MATERIAL FOR RUN 33B (Sheet 4 of 6)

Date	2/18		2/18		2/19		2/19		2/19		2/20	
Time	1200		2000		0400		1245		2000		0400	
Sample Portion	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total	Acceptor
Screen Size, Wt % Retained on Tyler Mesh												
8	12.6	28.4	15.7	35.1	11.8	29.7	7.8	28.1	13.0	30.1	14.7	28.6
9		17.4		17.0		18.8		21.5		18.7		17.9
10	15.7		16.3		14.5		21.3		14.7		14.5	
12		19.3		17.0		17.2		22.3		20.5		23.2
14	9.3	3.7	11.1	4.3	11.5	4.7	14.0	4.1	11.5	3.8	10.6	3.6
20	6.4	5.5	6.3	5.3	7.2	7.8	6.9	5.8	6.4	7.2	6.7	7.1
28	8.9	5.5	8.2	5.3	9.4	6.3	9.3	5.0	8.2	6.0	8.6	5.4
35	11.3		10.3		11.6		11.7		10.1		10.7	
48	13.0		12.9		13.1		14.1		13.2		12.8	
65	10.0	19.3	8.6	16.0	8.7	15.6	6.6	13.2	9.1	16.9	9.3	14.2
80		0.9				Tr						
100	7.9		6.8		7.0		6.4		7.4		7.4	
200	3.4		3.5		3.7		1.8		4.1		3.3	
Pan	1.5	Tr	0.3	Tr	1.7	Tr	0.1	Tr	2.2	Tr	1.3	Tr
Acceptor, Wt %	41.6		45.1		50.4		54.8		40.9		44.4	
Ash + SO_3, Wt % in Char	12.40		14.17		15.91		14.06		11.69		13.92	
Ash Elemental Analysis, Wt %												
SiO_2	16.73						17.05					
SO_3	1.97						1.34					
Na_2O	1.22						1.45					

Table 33-17. GASIFIER CHAR BED MATERIAL FOR RUN 33B (Sheet 5 of 6)

Date	2/20		2/20		2/21		2/21
Time	1230		2050		0400		1215
Sample Portion	Total	Acceptor	Total	Acceptor	Total	Acceptor	Total
Screen Size, Wt % Retained on Tyler Mesh							
8	13.5	28.2	6.1	30.5	15.9	29.1	11.5
9		19.7		22.8		19.8	
10	13.6		7.4		15.3		14.2
12		19.7		18.3		23.0	
14	11.2	4.2	7.4	3.8	9.3	4.0	10.1
20	7.4	7.0	8.0	6.1	6.0	5.2	7.1
28	9.8	5.6	12.4	5.0	8.4	4.3	9.3
35	11.1		14.9		11.2		11.4
48	14.6		18.1		13.5		13.9
65	9.3	15.5	11.7	12.7	9.9	14.4	9.9
80		Tr		0.5		0.1	
100	6.8		8.5		7.3		7.8
200	2.3		3.6		2.6		3.7
Pan	0.4	Tr	1.8	0	0.6	Tr	1.2
Acceptor, Wt %	47.8		47.2		47.2		45.3
Ash + SO_3, Wt % in Char	14.53		12.61		14.31		15.06
Ash Elemental Analysis, Wt %							
SiO_2	14.89						14.41
SO_3	1.79						1.82
Na_2O	1.97						1.45

Table 33-17. GASIFIER CHAR BED MATERIAL FOR RUN 33B (Sheet 6 of 6)

Date	← 2/10 →			← 2/11 →			2/12		← 2/13 →		
Time	0430	1100	1900	0145	1315	2130	0600	2030	0450	1130	2100
Screen Size, Wt %											
Tyler Mesh											
+35	Tr			2.6	Tr			0.2	0.3		Tr
35 X 48	0.2	Tr	0.2	0.2	0.1	0.1		0.2	1.3	0.5	Tr
48 X 65	3.3	5.2	4.8	3.4	3.7	2.3	1.4	1.0	2.1	1.6	1.2
65 X 100	21.0	22.1	21.8	20.8	22.4	19.0	14.1	11.4	2.9	7.8	11.6
100 X 200	37.7	34.6	38.0	37.6	30.1	43.0	41.8	38.7	5.7	25.7	42.0
200 X 325	17.0	10.8	9.9	13.8	33.9	12.9	13.6	18.7	6.0	14.0	15.7
-325	20.9	27.3	25.2	21.6	9.8	22.7	29.1	29.8	81.6	50.4	29.5
Ultimate Analysis, Wt %											
C		68.5	69.9		68.0		67.6	66.5		68.5	68.4
H		0.8	0.8		0.9		0.9	1.2		1.0	1.0
N		0.28			0.33		0.31			0.29	
S		0.21	0.20		0.18		0.32	0.38		0.50	0.20
Ash		24.21	23.94		25.37		25.65	26.58		27.62	25.23

Table 33-18. GASIFIER CHAR TO EXTERNAL CYCLONE FOR RUN 33B (Sheet 1 of 3)

Date	← 2/14 →			2/15	← 2/16 →			← 2/17 →			2/18
Time	0420	1050	2000	2110	0430	1130	2000	0300	1200	2030	0415
Screen Size, Wt %											
Tyler Mesh											
+35				Tr						Tr	
35 X 48		Tr	Tr	Tr	Tr	0.2	Tr	Tr	Tr	Tr	Tr
48 X 65	0.5	1.6	1.2	1.1	1.7	3.4	1.1	1.1	1.9	0.6	0.6
65 X 100	3.6	11.5	9.7	11.1	15.1	18.9	11.6	10.2	13.7	5.6	5.1
100 X 200	23.8	40.4	41.4	47.0	52.6	39.3	40.9	29.9	39.8	22.4	19.9
200 X 325	52.4	17.0	15.3	16.0		14.9	13.3	9.2	12.6	7.9	8.6
-325	17.7	29.5	32.4	24.9	30.6	23.2	33.1	49.5	32.1	63.5	65.8
Ultimate Analysis, Wt %											
C		69.0	68.4	65.5		72.3	68.4		67.6	68.8	
H		0.9	0.9	1.0		0.9	0.8		1.2	0.8	
N		0.31		0.33		0.35			0.30		
S		0.25	0.22	0.24		0.12	0.26		0.27	0.28	
Ash		25.10	24.10	24.33		21.72	25.32		25.15	25.08	

Table 33-18. GASIFIER CHAR TO EXTERNAL CYCLONE FOR RUN 33B (Sheet 2 of 3)

Date	2/18		← 2/19 →			← 2/20 →			← 2/21 →			2/22
Time	1140	1930	0250	1245	1900	0300	1230	2120	0245	1215	2115	1200
Screen Size, Wt %												
Tyler Mesh												
+35				Tr	Tr			Tr			Tr	
35 X 48	Tr	Tr		0.2	0.1	Tr	0.2	Tr	Tr	0.1	Tr	Tr
48 X 65	1.3	1.1	0.3	1.3	1.9	1.5	1.7	1.8	1.7	1.8	1.9	1.0
65 X 100	12.3	9.4	3.6	12.4	14.9	13.5	12.5	14.0	11.3	13.9	14.8	8.1
100 X 200	38.6	30.0	13.4	47.0	44.6	47.4	43.7	43.9	41.2	42.1	43.8	28.7
200 X 325	15.1	9.5	69.6	17.8	14.3	14.9	14.7	15.3	15.6	14.6	14.3	17.4
-325	32.7	50.0	12.7	21.3	24.2	22.8	27.0	24.9	30.3	27.5	25.2	44.8
Ultimate Analysis, Wt %												
C	67.5	69.3		66.5	66.8		68.4			68.7	65.8	
H	0.9	0.9		0.8	2.1		0.9			0.9	1.5	
N	0.31			0.28			0.31			0.33	0.31	
S	0.19	0.32		0.25	0.38		0.23			0.40	0.30	
Ash	24.81	24.36		27.03	23.93		23.84			25.00	22.21	

Table 33-18. GASIFIER CHAR TO EXTERNAL CYCLONE FOR RUN 33B (Sheet 3 of 3)

Date	2/10	2/11	2/12	2/13	2/14	2/15	2/16	2/17	2/18	2/19	2/20	2/21	2/22
Screen Size, Wt %													
Tyler Mesh													
+65	2.5	0.5	Tr						Tr	Tr	1.3	2.2	1.1
65 X 100	32.4	14.1	17.0	Tr	0.6	12.3	12.4	7.9	4.9	1.6	2.5	1.8	2.1
100 X 325	58.3	70.5	79.0	88.7	96.9	79.2	87.6	90.5	89.8	62.8	55.7	83.3	53.2
-325	6.8	14.7	4.0	11.3	2.5	8.5	Tr	1.6	5.3	35.6	40.5	12.8	43.6
Ultimate Analysis, Wt %													
C	58.7	64.7	67.0	67.0	63.9	69.3	72.2	69.5	69.2	65.9	70.3	70.2	70.6
H	0.74	0.9	0.9	1.3	1.9	2.6	1.8	1.2	1.2	1.0	1.1	1.0	1.2
N	0.24	0.30	0.27	0.24	0.26	0.30	0.32	0.23	0.29	0.28	0.21	0.21	.0.2
Total S	1.04	1.20	0.95	0.81	0.84	0.74	1.05	0.89	0.88	0.75	0.73	0.58	1.47
Ash	25.69	27.12	25.79	24.62	23.42	23.67	24.39	23.11	23.15	26.16	24.64	22.40	24.47
Ash Elemental Analysis, Wt %													
SiO_2	18.12	17.70	22.97	25.69	25.96	20.77	20.72	17.98	19.36	20.54	18.48	17.49	37.37
SO_3	9.47	11.21	9.06	8.94	9.80	8.45	10.81	10.39	9.05	7.70	8.00	9.00	14.93
Na_2O	1.78	1.18	1.95	2.22	2.29	1.27	1.58	2.17	1.97	1.74	1.50	1.59	2.18

Table 33-19. GASIFIER QUENCH TOWER SOLIDS COMPOSITES FOR RUN 33B

	2/10	2/11		2/12		2/13		2/14		2/15		2/16	
Time	0620	0300	0320	(1)	1130	(1)	(1)	1150	(1)	1200	(1)	1230	1720
Hopper	B	A	B	B	A	B	A	A	B	A	B	A	B
Screen Size, Wt %													
Tyler Mesh													
+35	1.4	1.4	1.4	9.8	0.3	8.5	0.3	4.7	9.5	7.2	9.0	6.9	9.9
35 X 48	4.3	0.7	4.1	4.4	1.0	6.4	1.0	2.1	5.0	3.8	6.0	4.8	6.1
48 X 65	8.2	1.4	8.9	6.3	2.2	8.8	1.5	3.3	7.6	5.6	8.2	6.8	8.4
65 X 100	11.5	2.1	14.6	8.3	31.6	11.0	2.2	4.5	9.8	7.5	10.8	9.7	11.0
100 X 200	22.7	5.3	26.0	15.0	7.1	20.5	4.7	10.3	20.2	15.8	20.2	19.0	20.0
200 X 325	15.4	4.2	14.0	12.4	19.0	18.9	6.1	13.2	21.4	10.9	11.8	14.7	11.6
-325	36.5	84.8	31.0	43.8	38.7	25.9	84.2	61.9	26.5	49.2	34.0	38.0	32.9
Ultimate Analysis, Wt %													
C	6.13	4.87	6.01	4.90	7.49	5.39	12.11	8.34	6.30	6.57	5.86	6.12	5.69
H	0.24	0.44	0.17	0.40	0.29	0.11	0.14	0.13	0.33	0.11	0.10	0.19	0.11
N	0.06	0.04	0.04	0.04	0.09	0.05	0.06	0.08	0.06	0.08	0.55	0.03	0.06
Sulfide	-	1.85	0.91	1.40	1.83	1.01	1.81	-	1.34	2.43	1.10	0.64	0.76
S Total	2.86	4.22	1.07	2.42	3.04	1.75	1.86	2.17	2.38	2.50	1.62	1.41	1.07
Ash + SO_3	93.13	95.85	93.56	93.42	92.35	94.15	88.85	92.40	94.42	95.98	95.37	94.21	94.56
Ash Elemental Analysis, Wt %													
SiO_2	22.36	14.65	23.56	21.35	14.87	22.16	14.18	15.72	18.04	16.19	20.47	20.71	22.79
SO_3	5.67	10.92	2.90	6.41	8.45	4.71	5.48	5.85	6.26	6.61	4.20	3.73	2.80
Na_2O	1.61	1.83	1.84	1.61	1.67	1.38	1.41	1.50	1.16	1.48	1.42	1.28	1.11
CaO	54.62	51.53	51.14	56.41	52.23	56.32	49.79	54.21	57.09	55.00	57.85	55.76	58.47
MgO	5.20	7.61	5.05	5.64	8.16	4.90	8.23	7.31	5.38	5.90	4.71	5.86	4.57
K_2O	0.97	0.98	0.98	1.06	1.12	0.87	1.20	0.84	0.77	0.41	1.11	0.40	0.65
P_2O_5	0.05	0.11	0.04	0.05	0.11	0.05	0.11	0.12	0.07	0.12	0.06	0.11	0.07
Al_2O_3	7.68	8.73	10.43	5.48	9.42	7.12	9.36	9.04	7.72	8.11	7.75	7.93	6.81
Fe_2O_3	2.48	3.34	2.32	2.62	3.81	2.51	4.06	3.83	2.97	3.33	2.75	3.13	2.61
TiO_2	Tr	0.25	0	0	0.26	0	0.25	0.58	0	0.87	0	0.57	0

(1) Daily Composite

Table 33-20. ASH AND ATTRITED ACCEPTOR FOR RUN 33B (Sheet 1 of 2)

Date	2/17		2/18		2/19		2/20		2/21		2/22	
Time	1300	(1)	1200	(1)	1000	(1)	0930	(1)	0930	(1)	1230	(1)
Hopper	A	B	A	B	A	B	A	B	A	B	A	B
Screen Size, Wt %												
Tyler Mesh												
+35	0.9	14.7	0.3	8.6	13.9	15.2	10.3	16.6	Tr	17.0	13.4	28.5
35 X 48		6.3	0.3	5.0	5.6	5.8	1.9	6.8	0.1	5.8	2.9	5.0
48 X 65	0.4	8.4	0.5	7.0	7.4	7.6	2.7	9.0	0.1	7.2	4.4	7.2
65 X 100	0.5	10.8	0.8	9.6	9.1	9.6	7.8	11.7	0.3	9.1	6.3	9.9
100 X 200	15.3	19.7	3.0	17.9	15.7	17.0	11.6	20.4	1.4	17.4	13.2	17.8
200 X 325	39.3	12.8	26.2	19.7	7.6	18.4	17.0	11.5	1.9	11.0	9.4	9.0
-325	43.6	27.3	69.1	32.2	40.7	26.4	48.8	24.0	96.1	32.6	50.2	22.6
Ultimate Analysis, Wt %												
C	6.63	5.14	6.64	6.52	5.25	5.12	6.78	6.30	7.30	7.26	8.5	15.05
H	0.30	0.19	0.02	0.19	0.14	0.14	1.03	0.21	0.16	0.26	0.2	0.15
N	0.08	0.06	0.07	0.06	0.05	0.10	0.08	0.09	0.03	0.07	0.1	0.04
Sulfide	2.17	0.83	1.79	0.69	0.41	0.56	1.69	0.69	1.81	0.24	1.11	0.58
S Total	3.54	0.99	3.65	1.11	0.66	0.93	3.40	1.05	3.85	1.66	2.56	0.63
Ash + SO_3	96.10	95.30	95.71	92.92	94.16	94.30	88.20	93.66	94.80	93.76	90.70	84.65
Ash Elemental Analysis, Wt %												
SiO_2	11.95	19.00	12.68	22.14	25.65	23.16	13.82	23.47	10.10	19.88	19.50	12.83
SO_3	8.90	2.55	9.63	2.95	1.71	2.45	9.58	2.79	10.16	4.44	5.77	1.72
Na_2O	1.34	0.95	1.28	1.08	0.08	0.86	0.87	1.05	1.35	1.37	1.28	0.53
CaO	55.60	63.29	54.52	58.68	56.42	60.00	54.89	58.56	55.88	58.03	56.35	74.74
MgO	7.30	4.33	7.33	4.59	7.22	4.14	6.97	4.48	7.52	5.15	5.18	3.51
K_2O	0.49	0.59	0.52	0.75	0.31	0.69	0.46	0.78	0.54	0.87	0.33	0.38
P_2O_5	0.16	0.05	0.16	0.06	0.51	0.06	0.16	0.05	0.16	0.07	0.13	0.04
Al_2O_3	7.74	6.95	7.98	7.13	7.63	6.79	8.30	6.62	8.47	7.51	8.27	4.74
Fe_2O_3	3.87	2.31	3.99	2.85	3.39	2.39	3.63	2.56	3.83	2.76	3.35	2.26
TiO_2	0.98	0	0.98	0	0.21	0	1.00	0	0.85	0	0.94	0

(1) Daily Composite

Table 33-20. ASH AND ATTRITED ACCEPTOR FOR RUN 33B (Sheet 2 of 2)

Date	Time	Tube	Distance from Bottom of Catalyst, ft-in. 0	0-6	1-6	2-6	3-6	4-6	5-6	5-7	5-8	5-9	5-10	5-11
			Temperatures, °F											
2/14	1820	2	610	620	625	631	642	665	724	-	-	770	-	-
↓	↓	3	615	619	622	631	643	665	736	-	-	771	-	-
		6	612	617	619	627	642	663	735	-	-	770	-	-
2/16	2110	2	551	-	563	-	587	618	708	725	750	770	795	810
2/17	1845	6	562	-	565	-	596	630	736	760	778	792	801	798
2/19	0015	3	530	-	538	-	539	606	722	742	-	790	812	829
2/20	0415	2	545	-	555	-	587	617	719	740	777	800	820	831
2/21	1403	3	545	-	550	-	578	605	730	760	781	795	819	830

Date	Time	Tube	Distance from Bottom of Catalyst, ft-in. 6-0	6-1	6-2	6-3	6-4	6-5	6-6	Dowtherm Circulation Rate, GPM	Dowtherm Temperature, °F In - Out
			Temperatures, °F								
2/14	1820	2	808	-	-	-	-	-	687	193	626 - 630
↓	↓	3	810	-	-	-	-	-	665	193	↓ ↓
		6	792	-	-	-	-	-	642	193	
2/16	2110	2	832	845	841	810	760	705	667	192	560 - 577
2/17	1845	6	800	772	758	-	-	-	605	188	568 - 579
2/19	0015	3	820	804	759	-	-	-	599	187	535 - 549
2/20	0415	2	842	841	823	775	722	-	645	60	551 - 573
2/21	1403	3	821	806	773	729	678	650	620	35	545 - 566

Table 33-21. PACKED TUBE METHANATOR TEMPERATURE PROFILES FOR RUN 33B

Date	2/13/76	2/13/76	2/13/76	2/13/76	2/13/76	2/13/76	2/13/76
Time	0135	0530	0900	1245	1650	2030	2330
Carbonate Tower							
Feed Gas, SCFH (Wet)	18,492	18,559	18,946	21,989	22,354	22,344	22,239
Feed Gas, SCFH (Dry)	18,313	18,416	18,782	21,714	22,117	22,133	22,042
Temperature, °F	113	105	109	122	116	112	111
Pressure, PSIG	130	130	130	130	130	130	135
Compositions, Mol %							
H_2 (Dry)	58.50	58.70	60.56	59.10	59.00	59.26	59.70
N_2 (Dry)	3.90	3.50	3.70	3.70	4.10	3.10	3.60
CO (Dry)	14.60	14.20	13.51	13.80	12.20	13.81	13.60
CH_4 (Dry)	12.90	12.70	12.41	13.00	13.60	13.71	13.30
CO_2 (Dry)	10.10	10.90	9.81	10.40	11.10	10.11	9.80
H_2O	0.97	0.77	0.87	1.25	1.06	0.94	0.89
MW (Wet)	12.93	13.01	12.40	12.82	12.88	12.63	12.52
HHV, BTU/SCF (Dry)	367	364	365	367	368	375	371
Methanator Feed							
Feed Gas, SCFH (Wet)	11,631	11,543	10.986	16,496	18,900	18,364	18,466
Feed Gas, SCFH (Dry)	10,453	10,479	9,944	14.805	16,248	17,069	16,761
Temperature, °F (1)	469	507	529	555	550	596	608
Temperature, °F (2)	486	500	502	496	488	500	483
Temperature, °F (3)	558	570	573	573	587	597	590
Pressure, PSIG	108	108	110	110	111	110	109
Compositions, Mol %							
H_2 (Dry)	61.90	63.20	60.50	62.20	62.30	61.46	62.20
N_2 (Dry)	5.00	4.40	4.40	4.00	4.30	3.60	4.50
CO (Dry)	15.90	15.20	15.30	14.90	14.40	13.81	14.70
CH_4 (Dry)	14.30	13.90	13.70	13.50	14.00	13.81	14.40
CO_2 (Dry)	2.90	3.30	6.10	5.40	5.00	7.31	4.20
H_2O*	10.14	9.22	9.49	10.25	14.03	7.05	9.23
MW (Wet)	11.42	11.14	12.23	11.80	11.93	12.01	11.46
HHV, BTU/SCF (Dry)	396	394	384	386	389	383	394
Recycle Rate							
Feed Gas, SCFH (Wet)	34,299	35,669	33,257	41,453	37,748	37,214	40,298
Feed Gas, SCFH (Dry)	33,736	35,146	33,143	41,280	37,595	37,082	40,160
Temperature, °F	206	200	158	154	155	158	157
Pressure, PSIG	137	160	130	150	120	130	130
Compositions, Mol %							
H_2 (Dry)	13.39	1.90	1.70	1.70	2.50	1.80	6.59
N_2 (Dry)	8.44	8.80	9.60	7.30	7.70	6.10	7.09
CO (Dry)	8.26	0.00	0.00	0.00	0.00	0.00	0.00
CH_4 (Dry)	69.91	87.20	84.80	87.70	88.50	84.30	86.31
CO_2 (Dry)	0.00	2.10	3.90	3.30	1.30	7.80	0.00
H_2O	1.64	1.47	0.34	0.42	0.41	0.35	0.34
MW (Wet)	16.19	17.43	18.04	17.60	16.98	18.70	15.97
HHV, BTU/SCF (Dry)	776	887	862	891	902	857	893
Adiabatic Reactor							
Feed Gas, SCFH (Wet)	7,367	7,362	7,540	6,341	7,840	7,990	9,040
Feed Gas, SCFH (Dry)	7,247	7,254	7,514	6,314	7,809	7,962	9,009
Temperature, °F	120	116	69	75	75	71	71
Pressure, PSIG	90	90	90	90	93	93	96
Compositions, Mol %							
H_2 (Dry)	13.39	1.90	1.70	1.70	2.50	1.80	6.59
N_2 (Dry)	8.44	8.80	9.60	7.30	7.70	6.10	7.09
CO (Dry)	8.26	0.00	0.00	0.00	0.00	0.00	0.00
CH_4 (Dry)	69.91	87.20	84.80	87.70	88.50	84.30	86.31
CO_2 (Dry)	0.00	2.10	3.90	3.30	1.30	7.80	0.00
H_2O	1.64	1.47	0.34	0.42	0.41	0.35	0.34
MW (Wet)	16.19	17.43	18.04	17.60	16.98	18.70	15.97
HHV, BTU/SCF (Dry)	776	887	862	891	902	857	893
Water Make, L8/HR	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dowtherm Circulation Rate, L8/HR	75,950	75,610	75,470	75,610	75,320	75,030	75,080
Temperature to DC-402, °F	595	605	610	605	615	625	623
Temperature from DC-402, °F	599	608	610	606	615	631	627
Dowtherm Condensed, L8/HR	0	0	0	0	0	0	0
Condensed Dowtherm Temperature, °F	-	-	-	-	-	-	-

*NOTE: The percent moisture was determined using published vapor pressure curves for H_2O over solutions of potassium carbonate

(1) Temperature at flow measuring orifice
(2) Temperature of methanator feed plus recycle gas at reactor inlet
(3) Temperature of reactor effluent

Table 33-22. METHANATION SECTION PROCESS DATA FOR RUN 33B (Sheet 1 of 4)

Date	2/14/76	2/14/76	2/15/76	2/15/76	2/15/76	2/16/76	2/16/76
Time	1030	1540	0900	1540	2330	0900	1500
Carbonate Tower							
Feed Gas, SCFH (Wet)	23,099	22,583	22,703	29,846	29,739	29,977	30,962
Feed Gas, SCFH (Dry)	22,868	22,316	22,476	29,651	29,504	29,746	30,707
Temperature, °F	114	120	114	100	106	105	107
Pressure, PSIG	130	130	130	132	130	130	129
Compositions, Mol %							
H_2 (Dry)	60.20	58.90	58.90	58.96	59.20	59.90	59.40
N_2 (Dry)	3.10	3.70	3.70	3.40	3.90	3.40	3.40
CO (Dry)	14.10	14.20	13.80	13.81	13.80	13.40	14.00
CH_4 (Dry)	12.90	12.90	13.10	13.11	13.30	13.40	13.60
CO_2 (Dry)	9.70	10.30	10.50	10.71	9.80	9.90	9.60
H_2O	1.00	1.18	1.00	0.65	0.79	0.77	0.82
MW (Wet)	12.43	12.87	12.86	12.86	12.64	12.46	12.52
HHV, BTU/SCF (Dry)	371	367	367	368	370	372	375
Methanator Feed							
Feed Gas, SCFH (Wet)	18,965	18,731	18,283	20,236	21,780	22,298	23,981
Feed Gas, SCFH (Dry)	17,058	16,890	16,444	18,273	19,711	20,189	21,734
Temperature, °F (1)	610	618	618	625	643	641	642
Temperature, °F (2)	489	519	528	519	522	523	548
Temperature, °F (3)	597	596	553	555	540	579	559
Pressure, PSIG	110	110	110	112	110	111	112
Compositions, Mol %							
H_2 (Dry)	63.80	63.00	61.80	61.50	61.90	62.76	62.84
N_2 (Dry)	3.90	3.70	3.60	4.10	4.40	3.60	4.70
CO (Dry)	14.90	15.20	14.70	14.00	14.90	14.31	13.89
CH_4 (Dry)	13.80	14.10	14.10	13.90	14.10	14.01	14.29
CO_2 (Dry)	3.60	4.00	5.80	6.50	4.70	5.31	4.30
H_2O*	10.05	9.83	10.06	9.70	9.50	9.46	9.37
MW (Wet)	11.12	11.32	11.87	12.04	11.65	11.54	11.34
HHV, BTU/SCF (Dry)	394	395	390	385	391	391	392
Recycle Rate							
Feed Gas, SCFH (Wet)	43,062	40,260	41,814	42,336	43,951	46,965	30,635
Feed Gas, SCFH (Dry)	42,925	40,068	41,655	42,187	43,838	46,853	30,504
Temperature, °F	154	163	154	160	156	150	167
Pressure, PSIG	150	130	150	120	130	150	130
Compositions, Mol %							
H_2 (Dry)	6.10	8.10	1.80	1.50	2.00	2.30	2.10
N_2 (Dry)	7.00	7.80	10.10	10.70	7.50	6.80	7.10
CO (Dry)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CH_4 (Dry)	86.90	84.10	88.10	87.80	88.60	88.00	89.40
CO_2 (Dry)	0.00	0.00	0.00	0.00	1.90	2.90	1.40
H_2O	0.32	0.48	0.38	0.35	0.26	0.24	0.43
MW (Wet)	16.03	15.85	17.00	17.12	17.19	17.35	16.99
HHV, BTU/SCF (Dry)	897	876	896	892	901	896	910
Adiabatic Reactor							
Feed Gas, SCFH (Wet)	8,390	8,081	7,592	8,753	8,805	8,527	9,117
Feed Gas, SCFH (Dry)	8,363	8,043	7,563	8,723	8,783	8,507	9,078
Temperature, °F	68	80	73	70	61	59	75
Pressure, PSIG	93	93	93	90	90	90	87
Compositions, Mol %							
H_2 (Dry)	6.10	8.10	1.80	1.50	2.00	2.30	2.10
N_2 (Dry)	7.00	7.80	10.10	10.70	7.50	6.80	7.10
CO (Dry)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CH_4 (Dry)	86.90	84.10	88.10	87.80	88.60	88.00	89.40
CO_2 (Dry)	0.00	0.00	0.00	0.00	1.90	2.90	1.40
H_2O	0.32	0.48	0.38	0.35	0.26	0.24	0.43
MW (Wet)	16.03	15.85	17.00	17.12	17.19	17.35	16.99
HHV, BTU/SCF (Dry)	897	876	896	892	901	896	910
Water Make, LB/HR	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dowtherm Circulation Rate, LB/HR	75,030	75,180	76,230	76,850	77.090	75,950	76,850
Temperature to DC-402, °F	625	620	585	565	555	595	565
Temperature from CD-402, °F	630	625	589	582	563	603	588
Dowtherm Condensed, LB/HR	0	0	0	0	0	0	0
Condensed Dowtherm Temperature, °F	-	-	-	-	-	-	-

*NOTE: The percent moisture was determined using published vapor pressure curves for H_2O over solutions of potassium carbonate.

(1) Temperature at flow measuring orifice
(2) Temperature of methanator feed plus recycle gas at reactor inlet
(3) Temperature of reactor effluent

Table 33-22. METHANATION SECTION PROCESS DATA FOR RUN 33B (Sheet 2 of 4)

Date	2/16/76	2/17/76	2/17/76	2/17/76	2/18/76	2/18/76	2/18/76
Time	2330	0900	1530	2315	0900	1600	2310
Carbonate Tower							
Feed Gas, SCFH (Wet)	30,602	30,512	29,989	30,445	30,045	30,467	29,937
Feed Gas, SCFH (Dry)	30,353	30,259	29,731	30,200	29,810	30,215	29,685
Temperature, °F	107	107	108	107	105	107	107
Pressure, PSIG	130	128	127	132	128	128	126
Compositions, Mol %							
H_2 (Dry)	59.60	60.04	59.33	59.16	59.16	60.16	59.20
N_2 (Dry)	3.50	3.60	3.77	3.30	3.20	3.20	3.70
CO (Dry)	14.10	14.39	14.58	13.51	13.61	14.01	13.90
CH_4 (Dry)	13.60	13.09	12.80	13.61	13.51	13.21	13.50
CO_2 (Dry)	9.20	8.89	9.52	10.41	10.51	9.41	9.70
H_2O	0.82	0.83	0.86	0.81	0.78	0.83	0.84
MW (Wet)	12.41	12.31	12.63	12.71	12.74	12.34	12.60
HHV, 8TU/SCF (Dry)	376	373	368	373	372	373	373
Methanator Feed							
Feed Gas, SCFH (Wet)	23,572	23,826	24,590	23,515	23,904	23,900	23,816
Feed Gas, SCFH (Dry)	21,418	21,746	22,578	21,301	21,767	21,777	21,688
Temperature, °F (1)	654	653	653	649	647	646	645
Temperature, °F (2)	552	549	544	549	544	545	554
Temperature, °F (3)	547	552	542	533	530	537	515
Pressure, PSIG	112	112	112	110	112	110	112
Compositions, Mol %							
H_2 (Dry)	62.10	63.11	64.24	62.30	62.76	63.30	62.30
N_2 (Dry)	4.40	3.35	3.60	4.50	4.40	3.80	4.60
CO (Dry)	14.80	15.45	15.68	14.50	14.81	14.80	14.80
CH_4 (Dry)	13.90	13.41	13.99	14.10	13.81	14.00	14.00
CO_2 (Dry)	4.80	4.67	2.50	4.60	4.20	4.10	4.30
H_2O*	9.14	8.73	8.18	9.42	8.94	8.88	8.93
MW (Wet)	11.62	11.38	10.69	11.54	11.37	11.20	11.47
HHV, 8TU/SCF (Dry)	389	390	400	391	390	394	391
Recycle Rate							
Feed Gas, SCFH (Wet)	29,942	32,339	33,520	33,581	33,742	33,673	30,066
Feed Gas, SCFH (Dry)	29,833	32,222	33,398	33,467	33,636	33,543	29,957
Temperature, °F	169	161	161	165	158	162	165
Pressure, PSIG	125	150	150	150	150	150	150
Compositions, Mol %							
H_2 (Dry)	2.10	2.10	3.90	3.00	3.40	3.60	3.00
N_2 (Dry)	6.70	7.60	7.00	7.60	8.30	8.20	9.50
CO (Dry)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CH_4 (Dry)	89.20	87.10	89.10	89.40	88.30	88.20	87.50
CO_2 (Dry)	2.00	3.20	0.00	0.00	0.00	0.00	0.00
H_2O	0.36	0.36	0.36	0.34	0.32	0.39	0.36
MW (Wet)	17.11	17.55	16.34	16.54	16.56	16.53	16.76
HHV, 8TU/SCF (Dry)	908	887	913	913	903	902	893
Adiabatic Reactor							
Feed Gas, SCFH (Wet)	9,253	9,011	9,990	9,175	9,313	9,272	9,223
Feed Gas, SCFH (Dry)	9,219	8,978	9,954	9,144	9,283	9,236	9,190
Temperature, °F	71	70	71	68	66	72	70
Pressure, PSIG	90	87	90	87	87	87	87
Compositions, Mol %							
H_2 (Dry)	2.10	2.10	3.90	3.00	3.40	3.60	3.00
N_2 (Dry)	6.70	7.60	7.00	7.60	8.30	8.20	9.50
CO (Dry)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CH_4 (Dry)	89.20	87.10	89.10	89.40	88.30	88.20	87.50
CO_2 (Dry)	2.00	3.20	0.00	0.00	0.00	0.00	0.00
H_2O	0.36	0.36	0.36	0.34	0.32	0.39	0.36
MW (Wet)	17.11	17.55	16.34	16.54	16.56	16.53	16.76
HHV, 8TU/SCF (Dry)	908	887	913	913	903	902	893
Water Make, L8/HR	331	340	345	353	366	363	367
Dowtherm Circulation Rate, L8/HR	76,850	76,520	76,850	77,410	77,410	77,270	78,070
Temperature to DC-402, °F	565	575	565	543	545	550	520
Temperature from DC-402, °F	577	583	577	557	557	564	539
Dowtherm Condensed, LB/HR	0	1,595	2,055	2,295	3,135	2,766	2,458
Condensed Dowtherm Temperature, °F	-	489	515	512	463	516	599

*NOTE: The percent moisture was determined using published vapor pressure curves for H_2O over solutions of potassium carbonate.

(1) Temperature at flow measuring orifice
(2) Temperature of methanator feed plus recycle gas at reactor inlet
(3) Temperature of reactor effluent

Table 33-22. METHANATION SECTION PROCESS DATA FOR RUN 33B (Sheet 3 of 4)

Date	2/19/76	2/19/76	2/19/76	2/20/76	2/20/76	2/20/76	2/21/76	2/21/76
Time	0730	1600	2300	0740	1700	0100	0700	1600
Carbonate Tower								
Feed Gas, SCFH (Wet)	30,158	29,959	30,298	29,996	29,788	30,312	30,444	30,411
Feed Gas, SCFH (Dry)	29,916	29,733	30,084	29,819	29,535	30,081	30,194	30,120
Temperature, °F	106	103	102	95	108	104	106	112
Pressure, PSIG	128	125	130	125	128	127	125	128
Compositions, Mol %								
H_2 (Dry)	59.16	59.46	58.66	58.80	58.60	58.90	59.60	59.06
N_2 (Dry)	4.40	3.20	4.20	3.60	4.00	4.20	4.30	3.90
CO (Dry)	13.51	14.31	14.21	14.50	14.60	13.90	13.60	14.21
CH_4 (Dry)	13.31	13.21	13.21	13.30	12.80	12.40	12.70	12.81
CO_2 (Dry)	9.61	9.81	9.71	9.80	10.00	10.60	9.80	10.01
H_2O	0.80	0.75	0.70	0.59	0.85	0.76	0.82	0.96
MW (Wet)	12.62	12.58	12.77	12.73	12.89	12.95	12.61	12.78
HHV, BTU/SCF (Dry)	370	372	369	371	366	361	365	366
Methanator Feed								
Feed Gas, SCFH (Wet)	23,656	23,887	23,692	23,999	22,369	23,614	23,726	23,341
Feed Gas, SCFH (Dry)	21,451	21,676	21,538	21,862	20,955	21,657	21,709	20,918
Temperature, °F (1)	645	647	644	640	635	643	643	645
Temperature, °F (2)	557	557	556	555	549	549	550	553
Temperature, °F (3)	534	536	539	536	525	532	546	534
Pressure, PSIG	112	112	112	112	112	112	112	112
Compositions, Mol %								
H_2 (Dry)	61.94	62.80	61.80	62.50	58.40	62.00	62.36	61.30
N_2 (Dry)	4.60	3.70	4.90	4.60	4.60	3.90	5.01	4.70
CO (Dry)	14.39	15.50	15.00	15.10	13.60	15.20	14.31	13.40
CH_4 (Dry)	14.29	13.80	14.00	14.00	13.60	13.60	13.41	14.80
CO_2 (Dry)	4.80	4.20	4.30	3.80	9.80	5.30	4.90	5.80
H_2O*	9.32	9.26	9.09	8.90	6.32	8.29	8.50	10.38
MW (Wet)	11.62	11.38	11.60	11.35	13.10	11.69	11.58	11.94
HHV, BTU/SCF (Dry)	391	393	390	392	370	387	383	391
Recycle Rate								
Feed Gas, SCFH (Wet)	23,423	29,407	29,350	29,105	26,936	29,059	29,870	28,898
Feed Gas, SCFH (Dry)	29,323	29,297	29,267	29,025	26,835	28,964	29,761	28,797
Temperature, °F	165	162	161	159	161	160	164	179
Pressure, PSIG	150	150	150	150	155	155	155	150
Compositions, Mol %								
H_2 (Dry)	2.60	2.50	2.60	1.90	1.10	1.70	2.80	2.30
N_2 (Dry)	8.20	8.90	9.80	9.50	10.20	9.00	8.20	9.80
CO (Dry)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CH_4 (Dry)	89.20	88.60	87.60	87.60	76.10	86.20	88.80	87.90
CO_2 (Dry)	0.00	0.00	0.00	1.00	12.60	3.10	0.20	0.00
H_2O	0.34	0.38	0.28	0.27	0.38	0.33	0.36	0.35
MW (Wet)	16.66	16.76	16.85	17.20	20.62	17.75	16.69	16.90
HHV, BTU/SCF (Dry)	909	903	893	891	772	876	906	895
Adiabatic Reactor								
Feed Gas, SCFH (Wet)	9,267	9,341	9,258	9,300	9,444	9,110	9,242	9,195
Feed Gas, SCFH (Dry)	9,236	9,306	9,232	9,274	9,408	9,080	9,209	9,163
Temperature, °F	68	71	63	62	71	67	70	69
Pressure, PSIG	87	87	87	87	87	87	87	87
Compositions, Mol %								
H_2 (Dry)	2.60	2.50	2.60	1.90	1.10	1.70	2.80	2.30
N_2 (Dry)	8.20	8.90	9.80	9.50	10.20	9.00	8.20	9.80
CO (Dry)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CH_4 (Dry)	89.20	88.60	87.60	87.60	76.10	86.20	88.80	87.90
CO_2 (Dry)	0.00	0.00	0.00	1.00	12.60	3.10	0.20	0.00
H_2O	0.34	0.38	0.28	0.27	0.38	0.33	0.36	0.35
MW (Wet)	16.66	16.76	16.85	17.20	20.62	17.75	16.69	16.90
HHV, BTU/SCF (Dry)	909	903	893	891	772	876	906	895
Water Make, LB/HR	366	345	355	343	345	326	355	376
Dowtherm Circulation Rate, LB/HR	77,270	63,220	49,170	49,170	29,558	30,970	30,780	28,710
Temperature to DC-402, °F	550	550	550	550	543	545	560	548
Temperature from DC-402, °F	561	568	573	572	565	565	579	568
Dowtherm Condensed, LB/HR	3,167	2,051	3,144	1,813	1,272	2,840	1,959	1,718
Condensed Dowtherm Temperature, °F	510	396	454	380	269	520	414	405

*NOTE: The percent moisture was determined using published vapor pressure curves for H_2O over solutions of potassium carbonate.

(1) Temperature at flow measuring orifice
(2) Temperature of methanator feed plus recycle gas at reactor inlet
(3) Temperature of reactor effluent

Table 33-22. METHANATION SECTION PROCESS DATA FOR RUN 33B (Sheet 4 of 4)

RUN 34

RUN 34A MARCH 17 TO MARCH 22, 1976

RUN 34B MARCH 26 TO APRIL 1, 1976

CO_2 ACCEPTOR PROCESS GASIFICATION

PILOT PLANT

RAPID CITY, SOUTH DAKOTA

1 SUMMARY

The Run 34 series (Run 34A and Run 34B) was the first attempt to use the combination of Glenharold lignite, a medium sodium lignite, and 6 X 9 Tyler mesh Minnekahta limestone in a fully integrated plant. Neither of the runs in this series was of sufficient length to attain steady-state operation.

Two large hot spots on the regenerator acceptor lift line interrupted Run 34A after only 13.5 hours at process temperatures. The plant was immediately shut down due to the extent and the suddenness of their appearance.

A boot upset caused the demise of Run 34B after 51 hours at process conditions. Examination of the gasifier after shutdown showed a large boot deposit and a deposit above the gasifier ring.

Run 34 data are presented graphically and/or tabularly at the end of this run report. These tables include:

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3 SIGNIFICANT EVENTS AND OBSERVATIONS

3.1 TABULAR HISTORY OF RUN 34

3.1.1 Objectives

(1) Integrated plant operation using Glenharold lignite and Minnekahta limestone as feedstocks.

(2) Operation of the methanation unit.

(3) Voluntary shutdown after obtaining a steady-state balance period.

3.1.2 Accomplishments of Run 34A

(1) None of the major objectives were attained due to the shortness of the run.

(2) The system pressure control was adjusted to minimize pressure surges during an upset. After adjustment, the response proved satisfactory.

(3) An alternate method of controlling steam flow to the boot was tested. The boot steam can now be controlled via the total flow orifice (FT-2019). This orifice has proven to be more dependable than the steam orifice (FT-2021).

3.1.3 Accomplishments of Run 34B

(1) Glenharold lignite was fed to the system for 44 hours.

(2) Minnekahta limestone was fed for 40 hours.

3.1.4 Termination Cause of Run 34A

Two large hot spots appeared on the acceptor lift line, CD-208, shortly after obtaining process conditions. The sudden appearance and size of these hot spots led to the decision to shut down the plant.

3.1.5 Termination Cause of Run 34B

A boot upset occurred after 44 hours of lignite feed. Spent acceptor withdrawal from the gasifier was lost. Efforts to regain transfer proved futile. The cause of the acceptor transfer loss has not been definitely determined. A piece of refractory which was wedged in the inlet to the recarbonated acceptor standleg may have been responsible.

3.1.6 Mechanical Problems of Run 34A

(1) No major problems during operation.

(2) Examination of the acceptor lift line showed the lines and cones to be in good condition. The hot spot arose from insulation voids.

(3) A large refractory piece was found lodged in the recarbonated acceptor transfer line, CD-204.

(4) The air ring in the regenerator was damaged beyond repair and had to be replaced.

3.1.7 Mechanical Problems of Run 34B

(1) Some plugging of the Sweco oversize line in the coal grinding area was encountered.

(2) Cracks were discovered in the regenerator overhead water jacketed line.

3.1.8 Process Problems

(1) Minor scale buildup was observed in the gasifier quench venturi.

(2) A hard, layered buildup (3/8-inch maximum) was found in the gasifier quench tower.

(3) Agglomerated ash deposits formed on and around the gasifier side flow distributor ring.

3.2 CHRONOLOGY OF OPERATIONS

3.2.1 Run 34A

Date	Time	Hours Run	Description
3/17	1700		Began pressuring up the system.
"	2110		System up to pressure, started the static pressure test. NOTE: Due to excessive leaks, the plant was returned to maintenance.
3/18	1115		Maintenance finished tightening leaks, and the static pressure test was completed.
"	1200		Started all recycle gas compressors and established gas circulation.

Date	Time	Hours Run	Description
3/18	1450		Lit all heaters.
"	1715		Started refractory cure holding period at 250°F.
3/19	0615		Finished first holding period, raising heater temperatures.
"	0930		Started heater differential pressure tests.
"	1030		Finished heater differential pressure tests.
"	1515		Started refractory cure holding period at 700°F.
"	1915		Finished the second holding period, raising heater temperatures. Began grinding in the 100 area.
"	2120		Shut down 100 area grinding for maintenance.
3/20	0405		Started filling the gasifier boot with dead-burned dolomite via F-204A, lignite feed lockhopper.
"	0605		Transferred first batch of dead-burned dolomite from the gasifier to the regenerator.
"	0611		Started dead-burned dolomite feed to the regenerator via F-206, fresh dolomite lockhopper.
"	1020		Maintenance finished with 100 area, began grinding again.
"	1100		Experienced two power dips--no problems resulted.
"	1627		Started circulating dead-burned dolomite.
"	1700		Started the solids circulation test.
"	1730		Finished the solids circulation test.
"	1925		Began steam flow to the gasifier side.
"	2030		Started the gas circulation tests.
"	2100		Finished the gas circulation tests.
"	2110		Resumed solids circulation.
"	2142		Began feeding char to the gasifer via F-204A.
3/21	0100		Started air flow to the gasifier side.
"	0340		Initiated steam flow to the gasifier boot.
"	0715		Started auxiliary char feed to the regenerator.
"	0745		Established char transfer without problems.
"	0810		Stopped grinding in the 100 area.
"	1000	0	Regenerator at 1800°F.
"	1100		Switched gasifier boot steam control from FRC-2021 to FRC-2019, almost lost steam flow, resumed control through FRC-2021 and sent FRC-2019 to the instrument shop.
"	1130		Tried to switch boot steam controllers again without success.
"	1135	1.6	Lost acceptor circulation through LCV-2003. Stopped fresh dead-burned dolomite feed, maintaining regenerator temperature with auxiliary char.

Date	Time	Hours Run	Description
3/21	1400		Finally reestablished solids circulation.
"	1435		Switched gasifier boot steam control from FRC-2021 to FRC-2019 successfully.
"	1515		Resumed grinding in the 100 area.
"	1542		Began feeding Glenharold lignite to the gasifier via F-204A.
"	1545	0	Regenerator at 1800°F.
"	1750		Shut off lignite feed to check if PT-2022, gasifier pressure controller, and DPRC-2030, gasifier-regenerator pressure differential controller, would catch system swing. Both instruments functioned properly.
"	1840		Began fresh limestone feed to the regenerator.
"	1900		Started CO_2 to the gasifier boot.
"	2125		Began cutting air to the gasifier side.
"	2335	7.8	Large hot spots appeared on CD-208, acceptor lift line to regenerator, on third floor. Began shutdown procedures.
3/22	0930		System depressured.

3.2.2 Run 34B

3/26	1130		Began pressuring up the system using J-309, char lift gas compressor.
"	1400		System up to pressure. Started the static pressure test.
"	1530		Finished the static pressure test.
"	1830		Started all recycle gas compressors.
"	1835		Lit all heaters.
"	2330		System at 250°F, started 13 hour refractory cure holding period.
3/27	0905		J-201A, gasifier recycle gas compressor, shut down for maintenance.
"	0945		J-201A compressor on line.
"	1230		Finished the refractory cure holding period and began increasing system temperatures.
"	1700		Started the heater differential pressure tests.
"	1900		Finished the heater differential pressure tests.
"	2130		System at 700°F, began the four-hour refractory cure holding period.
3/28	0130		Finished the refractory cure holding period and began raising system temperatures.
"	0600		Zinc oxide system placed on line.
"	0815		J-201A shut down for maintenance.
"	0940		J-201A placed back on line.
"	1045		Initiated dead-burned dolomite feed to the gasifier via F-204A, lignite feed lockhopper.

Date	Time	Hours Run	Description
3/28	1305		Having trouble transferring dead-burned dolomite from the gasifier to the regenerator.
"	1630		Finally able to transfer dead-burned dolomite. Started feeding dead-burned dolomite to the regenerator via F-206, fresh dolomite feed lockhopper.
"	1815		F-206 outlet plugged.
"	1840		F-206 handed over to maintenance.
"	2015		F-206 outlet cleared, resumed feeding dead-burned dolomite to the regenerator.
3/29	0130		Began solids circulation.
"	0400		Started solids circulation tests.
"	0530		Finished solids circulation tests and started gas flow tests.
"	0620		Finished gas flow tests.
"	0640		Replaced recycle gas to the gasifier side with steam.
"	0712		Started feeding char to the gasifier via F-204A.
"	0750		Stopped solids circulation and char feed to establish the interface in the gasifier.
"	0820		Resumed solids circulation and char feed.
"	0940		Started grinding in the 100 area.
"	1004		S-10 sample station plugged; swung gasifier pressure trying to clear it.
"	1305		Initiated air flow to the gasifier side.
"	1530		Began replacing recycle gas to the gasifier boot with steam.
"	1850		Initiated auxiliary char feed to the regenerator.
"	1900		Established char transfer from the gasifier to the regenerator.
"	2040	0	Regenerator at 1800°F.
3/30	0345		Began feeding lignite to the system.
"	0800		Initiated limestone feed to the system.
"	0850		Began CO_2 gas flow to the gasifier boot.
"	1500	18.3	Began removing air from the gasifier side.
3/31	0745		One hundred area shut down for maintenance work.
"	0843		Started gas flow to the HPC unit of the methanation area.
"	0900	36.3	All air flow out of the gasifier side.
"	1321		Upset occurred in the gasifier boot, cut back on acceptor circulation, added air to the gasifier side to maintain temperature. Char transfer lost during the upset.
"	1350		System returning to normal. Char transfer regained.

Date	Time	Hours Run	Description
3/31	1415		Air removed from the gasifier side again. Grinding lignite in the 100 area.
"	1652		Recycle flow out of the gasifier boot.
"	1735		Lowering acceptor circulation in order to control a high gasifier bed density.
"	2200		Lost auxiliary char feed to the regenerator.
"	2215		Auxiliary char feed coming back slowly.
"	2325	50.7	Upset occurred in the gasifier boot. Cut acceptor circulation overhead, lost acceptor circulation through LCV-2003. Attempted to blow the gasifier interface, however, indications show that good mixing was not accomplished. Char transfer shut off.
4/1	0200		Attempting to establish an interface without success.
"	0330		Initiated plant shutdown procedures.
"	1300		Unit depressured.

4 RESULTS AND DISCUSSION

4.1 BACKGROUND

For the first time, Glenharold lignite and Minnekahta limestone (see Table 34-3) were used as feedstocks for the Rapid City Pilot Plant. The Glenharold lignite was a homogeneous feedstock containing a medium level of sodium (approximately seven-weight percent Na_2O on a sulfur free basis). Previous bench-scale studies indicated that high sodium concentrations in the coal ash could cause deposits in the gasifier. Thus, one of the prime objectives for Run 34 was to demonstrate that these deposits could be avoided.

4.2 ACCOMPLISHMENTS

4.2.1 Major Operational Achievements

The plant operation for the Run 34 series is summarized below:

SUMMARY OF PLANT OPERATION

	Run 34A	Run 34B
Acceptor Circulation, Hours	29	68
Process Conditions, Hours	13.5	51
Lignite Feed, Hours	8	44
Active Limestone Feed, Hours	5	40
Percent Steam to Gasifier Boot at Upset	-	100

4.2.2 Plant Data

Tables 34-1 through 34-10 summarize plant data for Run 34B. Run 34A data is not included due to the shortness of the run.

4.2.3 General Data

Run 34A and Run 34B were both of short duration. As a result, no meaningful information was collected with regard to steady-state heat and material balances, activity trends or intermediate fines. In addition, the methanation unit was not on stream.

4.3 PROBLEMS

4.3.1 Run 34A

(1) Regenerator. The regenerator had an extensive deposit around the air ring. There was a large hole in the ring at the gas inlet and 14 of the 24 bubble caps were damaged. The damage apparently occurred when the air line became detached from the gas distributor ring sometime during the run. The ring and connecting line were both replaced prior to Run 34B.

(2) Recarbonated Acceptor Withdrawal Line, CD-204. A large refractory chunk was found lodged in the lower spool piece. The chunk was approximately three inches and four and one-half inches long. The piece of refractory probably lodged in the line during the final day of operation when problems with the transfer of solids from the gasifier boot were experienced.

4.3.2 Run 34B

(1) Gasifier. Extensive deposits were found in the gasifier boot and around the side flow distributor ring (see Table 34-10 for analyses).

The boot deposit extended approximately 20 inches into the boot above the bottom head. The deposit was hard and appeared to consist of both dead-burned dolomite and active limestone. The boot gas distributor and the spent acceptor withdrawal to the dump hopper were covered, while the recarbonated acceptor withdrawal to the standleg was restricted. This deposit was probably the result of events which occurred after the initial upset which caused the loss of acceptor transfer from the gasifier boot. The acceptor particles probably fused together due to conditions of high steam partial pressure coupled with low boot temperature.

The gasifier side flow gas distributor ring was covered with a light weight brittle deposit. The deposit formed a tube-like structure in front of the gas outlets on the distributor ring. A comparison of the elemental analyses (sulfur free basis) of the Glenharold lignite ash and the ring deposit reveals that the deposit is apparently sodium enriched lignite ash. Under normal operating conditions, deposits of this nature do not form in the gasifier when Husky char or Velva lignite are used as feedstocks. The high amount of sodium in the Glenharold lignite ash is apparently responsible for the formation of the ring deposits.

During the Run 34 startup, an air-steam mixture was fed to the gasifier through the side flow gas distributor. This is the standard method of maintaining the gasifier char bed

temperature until a sufficient acceptor activity and circulation rate can be achieved to supply the gasifier heat duty. The air sufficiently raised the temperature around the gas distributor exit holes to cause some melting of the Glenharold lignite char ash. The sticky char particles then adhered to the gas distributor ring and eventually formed the deposits.

Analysis of the inclusions in the distributor ring deposit (see Table 34-10) showed that the inclusions were dead-burned dolomite. This provides additional evidence that the distributor deposit formed early in the run when the circulating acceptor was primarily dead-burned dolomite. There is a high probability that the distributor deposit can be avoided by minimizing or eliminating the use of air injection into the gasifier when Glenharold lignite is used as feedstock. The startup procedure would need minor modifications.

(2) Regenerator overhead water jacketed line. Cracks in the liner pipe were located at the flange of the line where it mates to the regenerator outlet nozzle. The line was repaired and placed back in service.

(3) Recarbonated acceptor withdrawal, CD-204. Inspection showed the line to be in good condition and clear except for a thin piece of refractory which was wedged in the line inlet. No other plugs or obstructions were observed.

(4) Gasifier quench venturi. The venturi and tee were inspected and a minor, random scale buildup (1/6-inch thick) was found in the diverging section of the venturi. The quench tower inlet had a hard, layered buildup. No visible buildup was observed in the tower itself. This scale, a result of $CaCO_3$ precipitation, was minor and appears to be adequately controlled by the Betz additives used in the venturi and quench tower makeup water.

(5) Gasifier external cyclone. The bottom cone section was replaced due to excessive metal erosion.

5 FUTURE PLANS

Future plans call for an extended length of operation with char feed to the gasifier. Char feed will continue until all air flow to the gasifier has been removed. Glenharold lignite will then be fed to the gasifier. This should prevent the formation of ash derived deposits on the gasifier side flow distributor ring.

Date	3/30/76	3/30/76	3/30/76	3/31/76	3/31/76	3/31/76
Time	0700	1500	2300	0700	1500	2300
Solids						
Feedstock	←		Glenharold Lignite			→
Feed Rate, lb/hr[1]	1,850	2,400	2,340	2,340	2,130	2,550
Cyclone Solids, lb/hr	216	222	212	141	137	137
Quench Tower Solids, lb/hr	37	7	14	30	52	12
Gas Flows[2]						
Boot Recycle, SCFH	20,800	16,500	14,300	6,000	0	0
Boot Steam, SCFH	18,100	22,200	26,200	32,600	33,400	37,200
CO_2 to Boot, SCFH	0	970	1,000	970	930	970
Steam to Side, SCFH	30,100	30,000	30,400	20,700	20,200	20,700
Air to Side, SCFH	21,000	16,500	11,400	2,900	0	0
Purges						
Recycle, SCFH	2,730	2,750	2,490	2,500	2,920	2,940
Inert, SCFH	990	860	960	700	830	860
Total Flow In, SCFH	93,720	89,780	86,750	66,370	58,280	62,670
Vent Rate, SCFH	60,800	66,300	60,200	45,700	48,400	53,500
Bed Conditions						
Boot Velocity, fps	1.94	2.08	2.10	1.96	2.00	1.89
Bed Velocity, fps	0.94	0.91	0.87	0.64	0.62	0.61
Boot Density, lb/ft^3[3]	105	101	96	90	87	81
Bed Density, lb/ft^3[3]	45	33	36	33	34	39
Boot Temperature, ^oF	1476	1499	1481	1471	1492	1464
Bed Temperature, ^oF	1483	1482	1484	1465	1485	1484
Overhead Gas Compositions, Mol %						
CO	15.8	17.0	15.5	14.1	15.0	14.0
CO_2	14.6	14.5	16.4	14.7	9.6	10.1
N_2	28.5	23.4	18.6	10.6	4.3	5.1
H_2	33.5	37.6	41.5	49.5	57.8	59.5
CH_4	5.6	7.3	8.0	11.1	11.0	11.

(1) Determined by feeder rpm - 422*RPM.
(2) Determined by orifice or rotameter flow meter measurements.
(3) Determined by differential pressure measurements.

Table 34-1. GASIFIER DATA FOR RUN 34B

Date	3/30/76	3/30/76	3/30/76	3/31/76	3/31/76	3/31/76
Time	0700	1500	2300	0700	1500	2300
Solids	Dead-Burned					
Acceptor Feedstock	Dolomite		← Minnekahta Limestone →			
Acceptor Makeup, lb/hr	359	560	560	560	560	560
Acceptor Circulation, lb/hr[1]	9,700	11,200	10,500	9,300	10,000	11,100
Ash and Attrited Acceptor, lb/hr[2]	-	152	101	176	132	128
Acceptor Withdrawal, lb/hr[2]	472	575	415	469	337	347
Auxiliary Char Feed, lb/hr	80	80	207	207	207	363
Gas Flows[3]						
Acceptor Lift, SCFH	54,000	54,000	53,300	53,100	53,900	53,600
Char Lift, SCFH	10,300	10,200	10,200	10,300	10,100	10,400
Air to Ring, SCFH	57,100	65,700	70,200	76,300	76,900	81,000
Recycle to Ring, SCFH	33,600	15,500	10,400	0	0	0
Purges						
Recycle, SCFH	3,370	2,700	2,040	2,790	2,820	2,320
Nitrogen, SCFH	2,670	2,550	2,120	2,250	2,040	1,740
Inert, SCFH	580	550	290	360	140	720
Total Flow In, SCFH	161,620	151,300	148,550	145,100	145,900	149,780
Vent Rate, SCFH	64,700	83,000	83,900	102,000	102,000	105,000
Bed Conditions						
Inlet Velocity, fps	2.90	2.70	2.66	2.60	2.62	2.68
Bed Density, lb/ft^3[4]	98	94	89	85	78	82
Average Bed Temperature, ^oF	1848	1831	1820	1838	1839	1820
Overhead Gas Analysis, Dry Mol %						
O_2	0	0	0	0	0	0
CO	2.5	3.1	2.0	6.5	2.9	1.2
CO_2	20.0	24.2	27.2	25.5	27.6	29.4
N_2	77.5	72.7	70.8	68.0	69.5	69.4

(1)
(2)Determined by lift line pressure drop.
(3)Determined by weigh scale.
(4)Determined by orifice or rotameter flow measurements.
Density determined by differential pressure.

Table 34-2. REGENERATOR DATA FOR RUN 34B

Screen Size, Wt % Tyler Mesh	Glenharold Lignite	Husky Char Feed to Regenerator	Screen Size, Wt % Tyler Mesh	Minnekahta Limestone
+8	1.4	0.9	+6	1.4
8 X 10	2.8	2.3	6 X 8	30.1
10 X 14	7.7	9.2	8 X 9	35.5
14 X 20	9.2	13.6	9 X 10	21.4
20 X 28	19.1	16.2	10 X 12	9.5
28 X 35	17.4	17.1	12 X 14	1.6
35 X 48	16.5	14.7	14 X 16	0.2
48 X 65	11.8	10.3	16 X 20	0.1
65 X 100	8.0	5.3	20 X 24	Tr
100 X 200	4.8	5.0	24 X 28	Tr
-200	1.3	5.4	-28	0.1
Particle Density, lb/cube	42.1(1)			
Moisture, Wt %	0.2	2.4		
Ultimate Analysis, Wt %				
C	65.4	72.9		
H + Moisture H	4.0	2.3		
N	0.9	0.7		
S	0.81	1.42		
Ash + SO_3	9.47	16.95		
Elemental Analysis, Wt %				
SiO_2	32.27	40.97		3.84
SO_3	16.24	19.15		0.01
Na_2O	5.92	2.29		0.05
CaO	25.10	19.39		94.11
MgO	6.24	4.65		0.84
K_2O	0.54	0.36		0.05
P_2O_5	0.04	0.04		0.02
Al_2O_3	8.26	8.85		1.02
Fe_2O_3	6.37	3.22		0.42
TiO_2	0.28	0.21		0.03

(1) Average of seven bulk densities.

Table 34-3. FEEDSTOCK COMPOSITES FOR RUN 34B

Date	3/30/76	3/31/76	4/1/76
Time	0400	0800	0000
Screen Size, Wt %			
Tyler Mesh			
+6		0.9	
6 X 8	1.4	11.7	11.2
8 X 9	0.6	10.7	
9 X 10	8.7	14.2	28.3
10 X 12	35.5	23.8	
12 X 14	32.3	21.7	41.2
14 X 16	16.0	10.6	
16 X 20	4.3	3.3	13.6
20 X 24	1.2	1.6	5.7
24 X 28		0.3	
-28		1.2	
Elemental Analysis, Wt %			
SiO_2		5.86	6.97
SO_3		1.31	1.33
Na_2O		0.24	0.44
CaO		69.01	67.09
MgO		20.38	19.84
K_2O		0.04	0.08
P_2O_5		0.02	0.02
Al_2O_3		1.71	1.79
Fe_2O_3		1.46	1.69
TiO_2		0.08	0.14
Sulfide	0.05	0.18	

Table 34-4. CALCINED ACCEPTOR RETURN FOR RUN 34B

Date	3/30/76	3/30/76	3/31/76
Time	0800	0800	2000
Screen Size, Wt %			
Tyler Mesh			
+6	-	0.5	0.5
6 X 8	0.7	5.4	9.7
8 X 9	0.5	6.2	12.5
9 X 10	5.0	11.6	18.1
10 X 12	30.8	26.2	26.1
12 X 14	34.9	27.4	17.7
14 X 16	19.5	14.0	8.1
16 X 20	6.6	5.1	3.0
20 X 24	1.2	1.5	2.3
24 X 28	0.3	0.3	0.6
-28	0.6	1.6	1.4
Particle Density, lb/cu ft		170	
Calcine Weight Change, Wt %	-1.5	-5.7	-7.1
Activity		0.11	0.10
Elemental Analysis, Wt %			
SiO_2	1.69	7.16	8.24
SO_3	0.87	1.78	2.05
Na_2O	0.08	0.51	1.18
CaO	55.21	67.17	70.06
MgO	39.57	18.96	14.73
K_2O	0.01	0.08	0.12
P_2O_5	-	-	-
Al_2O_3	0.96	2.17	2.16
Fe_2O_3	1.40	1.98	1.60
TiO_2	-	-	-
Sulfide	0.10	0.26	0.39

Table 34-5. RECARBONATED ACCEPTOR RETURN FOR RUN 34B

Date	3/30/76		3/31/76		3/31/76	
Time	0400		0400		2000	
Sample Type	Mix	Acceptor	Mix	Acceptor	Mix	Acceptor
Screen Size, Wt %						
Tyler Mesh						
+8	0.3	0.8	5.0	9.0	7.3	10.9
8 X 9		0.8		4.5		10.9
9 X 10	0.9		7.2		13.5	
10 X 12		43.2		39.3		32.7
12 X 14	27.2	22.0	31.5	16.8	24.1	11.5
14 X 20	15.9	20.3	13.4	16.8	9.8	14.6
20 X 28	10.2	2.5	7.1	4.5	6.5	5.4
28 X 35	13.6		8.6		8.2	
35 X 48	14.2		12.2		11.1	
48 X 65	9.9	10.2	8.3	7.9	8.7	12.7
65 X 80				1.1		0.6
80 X 100	6.2		5.2		6.5	
100 X 200	1.7		1.5		3.1	
-200			0.1		1.1	0.6
% Char	53.0		35.6		40.5	
% Ash + SO_3 in Char	20.4		15.6		16.7	
Elemental Analysis, Wt %						
SiO_2	24.35		18.27		18.36	
SO_3	14.83		10.44		9.12	
Na_2O	3.80		6.91		8.58	
CaO	27.74		36.72		34.01	
MgO	9.13		8.07		6.82	
K_2O	0.50		0.84		1.16	
P_2O_5	-		-		-	
Al_2O_3	10.86		7.68		12.57	
Fe_2O_3	4.27		6.99		6.43	
TiO_2	-		-		-	

Table 34-6. GASIFIER CHAR BED MATERIAL FOR RUN 34B

Date	3/30/76	3/31/76	3/31/76
Time	0500	0200	2115
Screen Size, Wt %			
Tyler Mesh			
+35			
35 X 48	0.1	0.6	0.2
48 X 65	1.2	4.4	2.7
65 X 100	14.8	20.6	15.4
100 X 200	43.0	35.5	35.4
200 X 325	13.1	12.8	29.6
-325	27.8	26.1	16.7
Ultimate Analysis, Wt %			
Moisture	0		0
C	67.2		66.9
H	1.0		1.0
N	0.3		0.3
S	1.03		0.52
Ash + SO_3	29.04	27.25	26.24
Elemental Analysis, Wt %			
SiO_2	38.97	21.96	17.00
SO_3	8.14	5.97	5.27
Na_2O	7.74	7.46	9.67
CaO	21.37	36.44	39.68
MgO	6.62	8.65	7.52
K_2O	0.42	1.05	1.42
P_2O_5	-	0.08	0.09
Al_2O_3	10.09	8.96	8.95
Fe_2O_3	5.58	7.56	8.67
TiO_2	-	0.39	0.37

Table 34-7. GASIFIER CHAR TO EXTERNAL CYCLONE FOR RUN 34B

Date	3/29/76	3/30/76	3/31/76
Screen Size, Wt %			
Tyler Mesh			
+65	0.3	0.2	0
65 X 100	11.5	6.5	1.4
100 X 325	79.7	67.6	55.1
-325	8.5	25.7	43.5
Ultimate Analysis, Wt %			
C	60.6	63.8	65.3
H	1.2	1.0	0.9
S	1.59	0.74	1.04
Ash + SO_3	33.48	27.35	21.16
Elemental Analysis, Wt %			
SiO_2		21.27	19.60
SO_3		8.18	12.82
Na_2O		2.09	2.78
CaO		44.37	39.80
MgO		3.17	2.55
K_2O		0.20	0.45
P_2O_5		0.17	0.15
Al_2O_3		11.18	9.50
Fe_2O_3		8.58	11.04
TiO_2		0.60	0.54

Table 34-8. GASIFIER QUENCH TOWER SOLIDS FOR RUN 34B

Date	3/30/76	3/31/76	3/31/76
Time	2330	0815	Composite
Screen Size, Wt %			
Tyler Mesh			
+35	1.2		2.6
35 X 48	4.5	0.5	4.4
48 X 65	9.0	1.5	9.0
65 X 100	12.1	3.3	12.2
100 X 200	19.7	7.7	20.7
200 X 325	12.8	4.9	12.8
-325	40.7	82.0	38.4
Ultimate Analysis, Wt %			
C	6.0	5.2	5.3
H	0.3	0.2	0.4
N	0.3		
S	2.0	2.0	1.96
Ash + SO_3	97.5	98.5	97.8
Elemental Analysis, Wt %			
SiO_2	26.68	15.36	24.22
SO_3	7.62	12.78	8.60
Na_2O	5.66	4.51	4.34
CaO	36.88	45.47	43.81
MgO	6.86	8.45	7.12
K_2O	0.55	0.48	0.48
P_2O_5	0.06	0.05	-
Al_2O_3	9.21	7.83	7.84
Fe_2O_3	3.61	3.92	3.76
TiO_2	0.43	-	-

Table 34-9. ASH AND ATTRITED ACCEPTOR FOR RUN 34B

	Lower Boot		Upper Boot Tyler Screen Size					Distributor	Distributor Ring Deposit
	Face	Wall	+8	8 X 10	10 X 14	14 X 20	-20	Ring Deposit	Inclusions
Calcine Weight Change, %	-18.8	-19.0	+9.0	+7.4	-14.9	-11.3	-17.4	-1.1	-9.2
Elemental Analysis, Wt %									
SiO_2	5.83	5.62	10.06	7.26	5.20	5.41	36.66	40.91	7.38
SO_3	0.11	0.01	0.02	0.10	0.17	0.16	2.20	0.16	0.07
Na_2O	0.41	0.40	0.66	0.59	0.42	0.43	0.95	11.32	0.44
CaO	70.49	71.06	80.91	79.80	65.13	62.44	33.52	28.76	51.58
MgO	19.87	19.54	4.69	9.07	25.34	27.24	8.52	3.99	35.52
K_2O	0.07	0.06	0.10	0.09	0.09	0.07	0.32	0.35	0.01
P_2O_5	0.02	0.03	0.01	0.01	0.02	0.01	0.01	0.01	0.01
Al_2O_3	1.82	2.19	1.88	1.90	1.87	2.05	8.54	10.09	2.70
Fe_2O_3	1.66	1.66	1.40	1.33	1.75	2.00	10.05	3.86	2.28
TiO_2	0.01	0.02	0.02	0.02	0	0	0.34	0.26	0.10

Table 34-10. GASIFIER DEPOSITS FOR RUN 34B

RUN 35

APRIL 13 TO APRIL 25, 1976

CO_2 ACCEPTOR PROCESS GASIFICATION

PILOT PLANT

RAPID CITY, SOUTH DAKOTA

1 SUMMARY

Run 35 was conducted in order to demonstrate the technical feasibility of the CO_2 Acceptor Process using coal feedstocks with moderately high sodium contents. The feedstocks for the run were Glenharold lignite and local Minnekahta limestone. Although the run was not fully successful, enough data was collected to provide additional insight into the operational problems associated with the new feedstock. The experience gained has led to further modifications of the startup procedure. These modifications will be tested in the next run.

For Run 35, the startup and operating procedures were modified to the extent that the air injected into the gasifier during startup was removed while the process feedstock was Husky char. To avoid the formation of agglomerated ash deposits which formed in the gasifier transition section during Run 34, no air was to be fed to the gasifier after the feedstock was switched to Glenharold lignite. Early in a run, air is used to maintain gasifier temperature until the acceptor circulation rate and activity are high enough to supply the gasifier duty.

The gasifier bed density remained high during most of Run 35. This hindered the removal of air, thus delaying the increase in acceptor circulation. Since the feeding of lignite to the gasifier in earlier runs always resulted in a dramatic decrease in the gasifier char bed density, the decision was made in Run 35 to switch to Glenharold lignite before the air removal from the gasifier was completed. A lower gasifier char bed density and increased acceptor circulation resulted. This then allowed the removal of the small amount of remaining gasifier air. However, ash agglomeration in the vicinity of the gasifier side flow steam distributor again occurred. The run was finally terminated when acceptor transfer from the boot suddenly ceased and could not be regained. The upset resulted from the plugging of the entrance to the recarbonated acceptor standleg.

2 TEST DATA

Run 35 data are presented graphically and/or tabularly at the end of this run report. These figures and tables include:

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3 SIGNIFICANT EVENTS AND OBSERVATIONS

3.1 TABULAR HISTORY OF RUN 35

3.1.1 Objectives

(1) To demonstrate plant operability using a moderately high sodium content coal as the gasifier feedstock.

(2) Integrated steady-state operation for two days followed by voluntary shutdown.

(3) Operation of the methanation unit.

3.1.2 Accomplishments

Although lignite was fed to the gasifier for approximately 103 hours, the run failed to conclusively demonstrate that the process was tolerant of higher sodium content coals. The plant was shut down before the methanation unit could be placed on stream.

3.1.3 Termination Causes

The run ended when the transfer of solids from the gasifier boot suddenly ceased. Plant instrumentation indicated that a plug had formed in the boot at the inlet to the recarbonated acceptor standleg causing the acceptor level to rise into the transition section. Past experience has shown that this is almost always fatal.

3.1.4 Mechanical Problems

During inspection of the gasifier, a 72 square-inch metal plate was found in the boot. The plate was used as a wall guide anchor for the vertical temperature and pressure probes which are no longer in service. When the plate fell, some of the gasifier ring deposit may have broken away and then plugged the entrance to the standleg. It can also be postulated that the plate itself could have blocked the entrance to the standleg. In the attempts to regain control of the boot, the plate could have been blown away from the opening.

3.1.5 Process Problems

Run 35 was hampered by continually high gasifier char bed densities. This was primarily the result of an accumulation of intermediate fines (junk) material in the char bed. Due to the high bed density, acceptor circulation could not be increased enough to supply the gasifier heat duty while Husky char was used as feedstock. This

situation required the continued injection of air into the char bed through the ring distributor. Attempts to reduce the Husky char bed density via increased fixed carbon burnoff did not produce the results anticipated.

3.2 CHRONOLOGY OF OPERATIONS

Date	Time	Hours Run	Description
4/13	1120		Began pressuring up the unit with J-309, char lift gas compressor.
"	2000		Completed the static pressure test.
"	2045		Started all recycle compressors and began gas circulation.
"	2400		Lit all heaters except B-205, lift gas heater.
4/14	0030		Began grinding char for the preheater.
"	0700		Started the 250°F refractory cure holding period.
"	0815		B-205 heater repaired and lit.
"	0900		Finished the refractory cure holding period, continuing with system heatup.
"	2100		Finished the refractory cure.
"	2145		Began feeding dead-burned dolomite to the gasifier via F-204A, lignite feed lockhopper.
4/15	0350		Transferred a batch of dead-burned dolomite to the regenerator.
"	0405		Started filling the regenerator with dead-burned dolomite via F-206, fresh dolomite lockhopper.
"	1200		Established acceptor circulation.
"	1500		Experienced a hot line on the discharge of J-203, regenerator recycle gas compressors.
"	1655		Resumed solids circulation and began dead-burned dolomite makeup.
"	1725		Replaced the recycle gas to the gasifier side flow with steam.
"	1740		Initiated char feed to the gasifier via F-204A.
"	1810		Stopped acceptor circulation to establish the interface.
"	1815		The interface established, resumed acceptor circulation.
"	2138		Initiated air flow to the gasifier side.
4/16	0525		Introduced steam into the gasifier boot flow.
"	0550		Feeding auxiliary char to the regenerator.
"	0730		Established char transfer.
"	1755	0	Regenerator at 1800°F.

Date	Time	Hours Run	Description
4/18	0140		Losing acceptor circulation through CD-206 due to low regenerator bed level. NOTE: Discovered L-204 feeder with a sheared pin.
"	0440		L-204 feeder repaired, regaining regenerator bed level.
"	1950	50	Charged F-206 with 6 X 9 fresh limestone.
4/19	0115		Started CO_2 gas to the gasifier boot flow.
"	0130		Started reducing air to the gasifier side flow.
"	1715		Grinding Glenharold lignite for the preheater.
"	1903	73.8	Began feeding a lignite/char mixture to the gasifier via F-204B.
4/20	0730		All air removed from the gasifier side flow.
"	1153	90	Put air flow back to the gasifier side flow due to low char bed temperatures.
"	1200		Attempting to lower the density of the gasifier bed.
4/21	2115		Started withdrawing solids to F-215/216 vessels, char removal lockhoppers.
4/22	1000	136	Gasifier density lowered, started increasing acceptor circulation.
4/23	0515		Removed air from gasifier side flow.
"	1720		Lost acceptor circulation through LCV-2003. Regained circulation by stroking the valve.
"	1900	169	Lost acceptor circulation through LCV-2003 and regained it by stroking the valve.
4/24	0035		Again having problems transferring through LCV-2003.
"	0200	176	Lost acceptor transfer through LCV-2003. Unable to clear obstruction in line. Definite signs of a buildup in gasifier. Shut off dolomite makeup and lignite feed. Lowering gasifier boot heater and removing steam from boot flow.
"	0530		Attempting to go to F-213, purged dolomite lockhopper without success.
"	0810		Initiated shutdown procedures.
4/25	0400		Depressuring the system.

4 RESULTS AND DISCUSSION

4.1 BACKGROUND

Run 35 was an attempt to prove the technical feasibility of the CO_2 Acceptor Process using a moderately high sodium content coal. The data from Run 34 indicated high sodium coals could not be gasifier continually with air in the gasifier. The run showed that highly localized ash agglomerating conditions would exist at the gasifier side distributor due to the presence of oxygen in the air. Run 35 was specifically modified to avoid the use of air when Glenharold lignite was fed. The procedure was to operate the plant in such a way to allow the air to be removed while Husky char was the feedstock, then switch to Glenharold lignite. Char feed rate and auxiliary fuel char were to be varied to arrive at the targeted bed density. By increasing the auxiliary fuel char rate, the fixed carbon burnoff in the gasifier could be increased, which in turn would lower the char bed density and allow acceptor circulation to carry the heat load. As it was, low char bed densities were not achieved. The high bed density obtained held up the showering acceptor and forced a reduction in circulation rate.

When it became apparent that the process conditions stipulated in the startup procedure could not be achieved, the procedure was modified. Fresh acceptor was then fed to the process and Glenharold lignite was fed while a small amount of air was still being injected into the gasifier. Even so, the gasifier bed density remained above normal. It was found that by raising the feed rate in small increments, the bed density would drop enough to allow the remaining small amount of air to be slowly removed and acceptor circulation to be increased to carry the heat duty. This procedure did allow all the remaining air to be removed leaving only the lignite feed and acceptor circulation rates to be slowly increased to operating levels. Unfortunately, the lignite feed rate was increased faster than the process would allow resulting in a sharp drop in gasifier bed temperatures. This required resumption of air injection into the gasifier.

Other attempts to lower the bed density included operation of the char removal system and adjustments in the gasifier boot flow. The combination of these did allow the air to be removed before the run ended.

One apparent benefit of the increased acceptor residence time in the gasifier was the higher than normal activity of the limestone acceptor.

The data from the run indicates that even a small amount of oxygen will create ash agglomeration when coals with moderately high sodium levels are used as feedstocks. Analyses of deposits which formed on and

in front of the side flow distributor and bubble caps showed high levels of sodium (12 to 15 WT % Na_2O) and silica (45 to 46 WT % SiO_2). (See Table 35-15.) The deposits resembled "fingers" extending horizontally from the bubble caps approximately three to six inches long and one to two inches outside diameter. Some of these were found in the boot and one was lying in the entrance to the spent acceptor standleg.

4.2 INTERMEDIATE FINES

The high bed density encountered during the run was the result of accumulation of intermediate fines in the gasifier char bed. Figure 35-3 shows the concentration of "junk" material in the gasifier and regenerator beds for Run 35. For a discussion of the procedure for determining the intermediate fines concentrations, refer to the run report covering Runs 21, 22 and 23.

Figure 35-3 shows that for the majority of Run 35 the fines content of the gasifier char bed ranged between 14 to 16 percent. During more successful runs, such as Runs 28B and 33B, the fines contents were typically less than 10 and 12 percent respectively.

4.3 REGENERATOR DEPOSITS

Separate incidences occurred where the regenerator bottom temperature was allowed to exceed normal operating conditions. The deposits were made up of mostly calcium and silica (see Table 35-15). The deposit formed its own equilibrium geometry above the air ring and in no way affected operations at the plant. It consisted of three identifiable layers and extended 13 to 15 inches above the ring.

5 FUTURE PLANS

Plans for the next run include further modifications of the start-up and operating procedures. The gasifier will be charged with Husky char and lined out as usual with air injection being used to supply part of the gasifier heat requirements. Velva lignite will then be fed to the gasifier and the air will be removed while on this feedstock. Experience has shown that Velva lignite is tolerant of air in the gasifier. Finally, when the air is removed, the feedstock will be switched to Glenharold lignite to finish up the run.

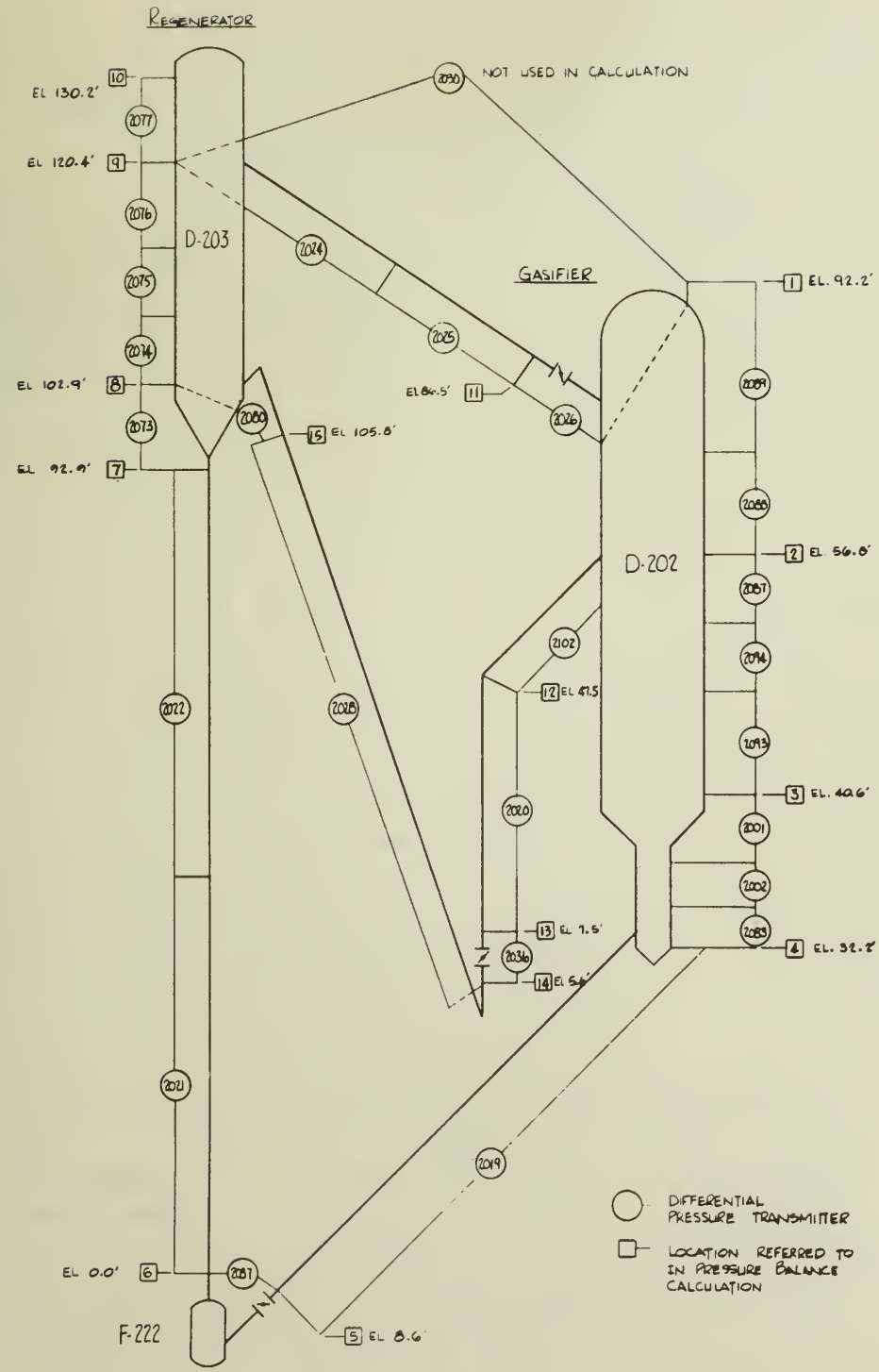

Figure 35-1. DIFFERENTIAL PRESSURE TRANSMITTER LOCATION PRESSURE BALANCE CALCULATION

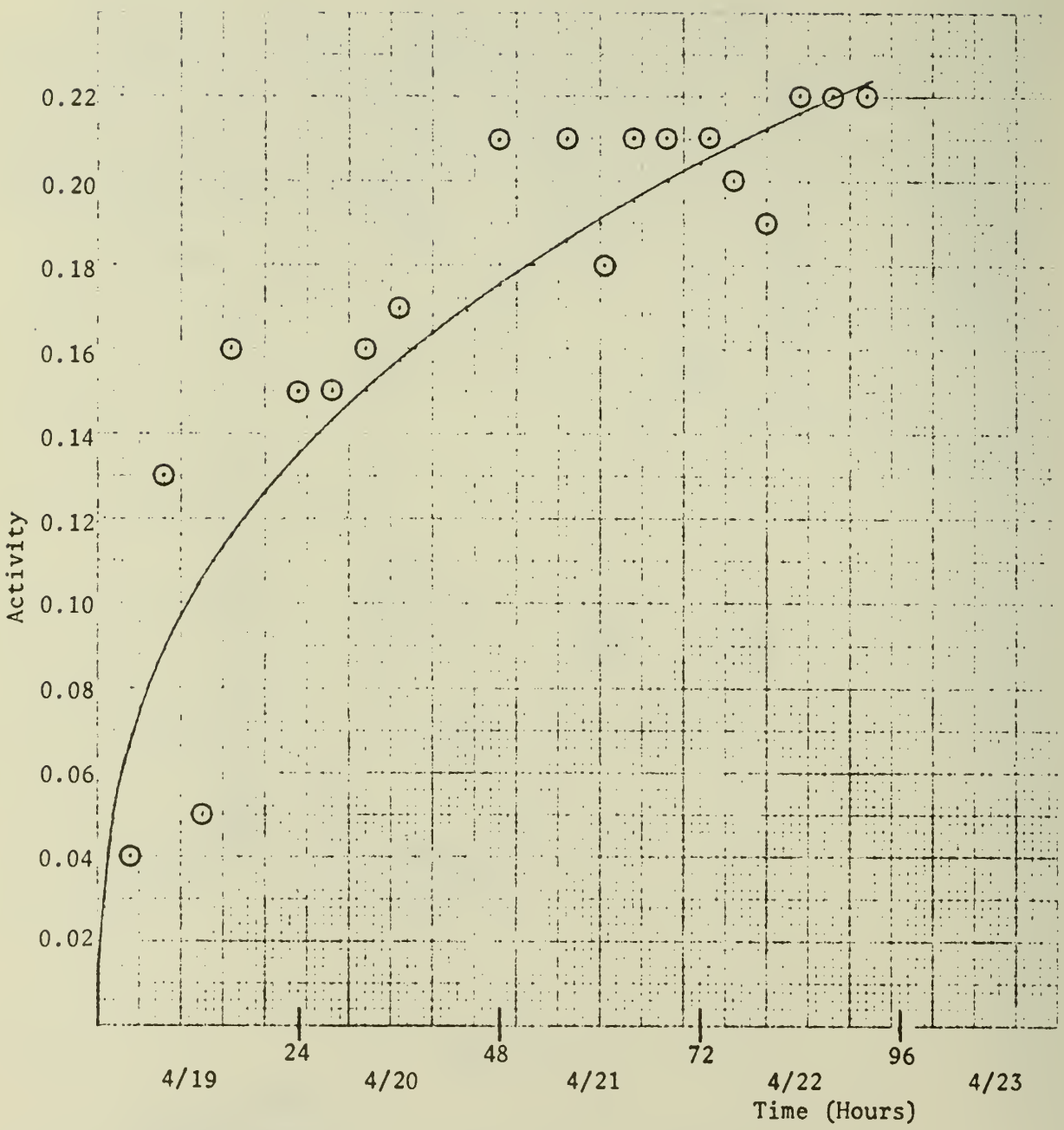

Figure 35-2. ACCEPTOR ACTIVITY FOR RUN 35

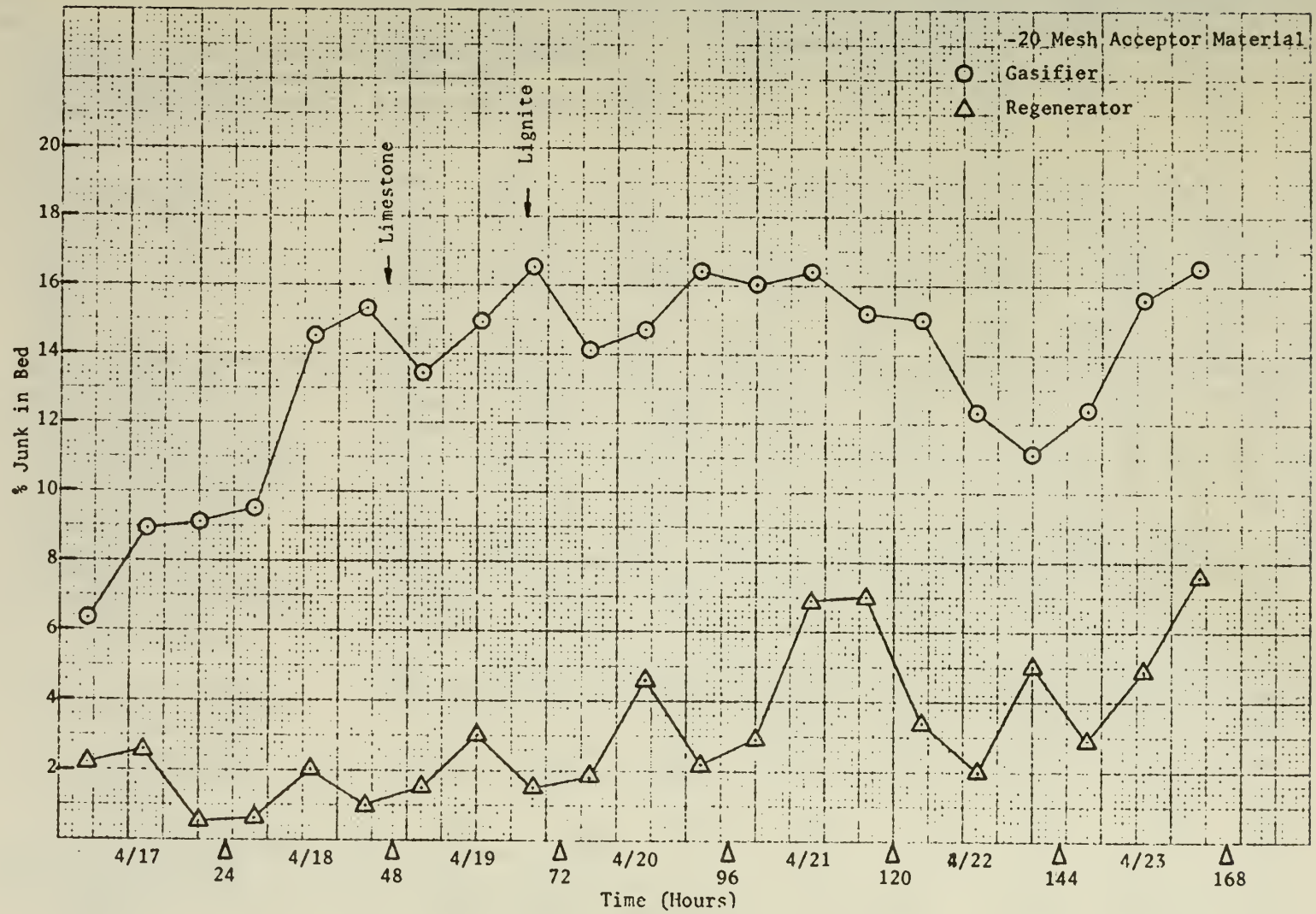

Figure 35-3. INTERMEDIATE FINES INVENTORY FOR RUN 35

Date	← 4/18/76 →			← 4/19/76 →			← 4/20/76 →		
Time	0700	1500	2300	0700	1500	2300	0700	1500	2300
Solids									
Feedstock	← Husky Char →						← Glenharold Lignite →		
Feed Rate, lb/hr[1]	1,430	1,300	1,520	1,260	1,170	1,430	1,850	2,310	2,100
Char Dump, lb/hr									
Cyclone Solids, lb/hr	160	200	264	120	170	152	234	150	98
Pond Solids, lb/hr	60	40	70	54	75	52	54	46	267
Gas Flows[2]									
Boot Recycle, SCFH	21,520	20,050	20,740	18,780	8,580	9,560	8,360	8,440	8,980
Boot Steam, SCFH	21,180	22,340	21,640	23,320	32,920	32,860	32,280	32,330	31,850
CO_2 to Boot, SCFH	0	0	0	1,000	940	970	960	930	960
Steam to Side, SCFH	30,770	36,370	30,760	30,480	20,270	20,220	20,250	19,390	19,550
Air to Side, SCFH	19,190	23,080	19,320	15,400	6,240	5,250	3,200	5,190	4,340
Purges									
Recycle, SCFH	2,450	2,620	2,310	2,570	2,750	2,860	2,860	2,930	3,020
Inert, SCFH	1,810	1,900	1,970	1,970	1,970	1,970	1,900	2,100	2,130
Total Flow In, SCFH	96,920	106,370	96,740	93,520	73,670	73,690	69,810	71,310	70,780
Vent Rate, SCFH	59,540	73,230	61,580	57,250	41,760	40,620	46,010	49,700	53,850
Bed Conditions									
Boot Velocity, fps	2.06	2.08	2.06	2.06	2.07	2.06	2.01	2.01	2.06
Bed Velocity, fps	0.95	1.06	0.95	0.91	0.70	0.69	0.65	0.66	0.68
Boot Density, lb/ft^3[3]	99	99	96	93	90	87	80	80	78
Bed Density, lb/ft^3[3]	43	44	43	46	47	47	42	42	43
Boot Temperature, ^oF	1485	1495	1498	1524	1487	1492	1502	1485	1510
Bed Temperature, ^oF	1481	1495	1495	1519	1485	1478	1489	1452	1487
Bed Height, ft	24.0	25.0	24.4	26.0	26.0	24.0	26.0	23.8	25.6
Overhead Compositions, Mol %									
CO	15.8	17.3	16.3	16.0	14.1	12.0	14.2	13.4	12.9
CO_2	13.9	14.4	14.7	11.9	15.5	12.8	13.6	12.3	10.1
N_2	33.4	32.3	32.1	28.4	18.2	18.4	14.1	13.3	12.1
H_2	33.0	33.0	34.4	29.6	46.5	47.2	48.8	50.4	49.3
CH_4	3.9	2.9	3.8	4.2	5.7	7.3	9.0	10.6	9.0
Acceptor Activity	0	0	0	0.13	0.16	0.15	0.15	-	0.21

(1) Determined by feeder rpm: 9.81 X Bulk Density X RPM
(2) Determined by orifice flow measurements
(3) Determined by differential pressure measurements

Table 35-1. GASIFIER DATA FOR RUN 35 (Sheet 1 of 2)

Date	4/21/76			4/22/76			4/23/76		
Time	0700	1500	2300	0700	1500	2300	0700	1500	2300
Solids									
Feedstock	Glenharold Lignite								
Feed Rate, lb/hr[1]	1,890	2,310	2,310	2,270	2,310	2,310	2,290	2,290	2,290
Char Dump, lb/hr			760	80	117	350	615	287	
Cyclone Solids, lb/hr	172	156	166	64	104	126	138	144	
Pond Solids, lb/hr	100	64	42	40	42	38	38	25	46
Gas Flows[2]									
Boot Recycle, SCFH	8,890	8,150	8,550	9,040	8,920	7,730	8,980	6,870	4,210
Boot Steam, SCFH	30,940	31,030	30,110	30,750	31,590	31,060	29,790	29,110	37,820
CO_2 to Boot, SCFH	960	940	970	940	950	960	960	930	960
Steam to Side, SCFH	20,780	20,860	21,070	21,220	21,100	20,570	21,290	20,530	21,340
Air to Side, SCFH	4,200	4,290	4,210	4,200	4,240	4,066	0	0	0
Purges									
Recycle, SCFH	3,040	3,240	3,440	3,510	3,480	3,240	3,660	3,350	3,640
Inert, SCFH	1,640	2,040	1,970	2,130	1,900	1,970	1,810	1,900	1,810
Total Flow In, SCFH	70,450	70,550	70,320	70,790	72,180	69,590	66,490	62,690	69,780
Vent Rate, SCFH	50,000	51,220	50,030	48,990	52,620	49,600	46,140	48,500	54,910
Bed Conditions									
Boot Velocity, fps	2.02	1.97	1.95	1.98	2.01	1.94	1.95	1.79	2.08
Bed Velocity, fps	0.67	0.66	0.66	0.66	0.67	0.65	0.61	0.58	0.65
Boot Density, lb/ft^3[3]	75	75	75	75	72	74	71	68	65
Bed Density, lb/ft^3[3]	47	46	42	35	36	37	38	33	35
Boot Temperature, ^oF	1500	1476	1489	1488	1510	1489	1504	1500	1497
Bed Temperature, ^oF	1488	1465	1461	1452	1479	1462	1470	1480	1498
Bed Height, ft	24.0	24.4	24.0	25.0	25.0	25.0	25.6	25.0	25.0
Overhead Compositions, Mol %									
CO	13.4	13.2	13.4	13.6	13.8	13.6	12.8	14.5	14.0
CO_2	10.6	12.1	11.4	10.6	11.3	10.4	9.3	9.0	9.7
N_2	12.4	10.8	10.1	8.8	8.9	9.0	4.3	4.2	3.8
H_2	54.3	52.8	53.0	54.7	55.9	54.4	60.3	60.0	60.7
CH_4	9.2	11.0	11.1	11.5	10.7	11.4	13.3	13.3	11.6
Acceptor Activity	0.21	0.21	0.21	0.19	0.22	0.22	0.23	0.21	-

(1) Determined by feeder rpm: 9.81 X Bulk Density X RPM
(2) Determined by orifice flow measurements
(3) Determined by differential pressure measurements

Table 35-1. GASIFIER DATA FOR RUN 35 (Sheet 2 of 2)

Date	4/18/76			4/19/76			4/20/76		
Time	0700	1500	2300	0700	1500	2300	0700	1500	2300
Solids									
Acceptor Feedstock	Dead-Burned Dolomite		Minnekahta Limestone						
Acceptor Makeup, lb/hr	360	360	560	560	560	560	560	560	560
Acceptor Circulation, lb/hr[1]	6,650	8,160	6,990	6,720	5,240	5,240	7,590	5,240	5,220
Ash and Attrited Acceptor, lb/hr[2]								114	104
Acceptor Withdrawal, lb/hr[2]	200	210	540	325	295	375	355	500	335
Auxiliary Char Feed, lb/hr	190	200	270	290	390	420	370	200	160
Gas Flows[3]									
Acceptor Lift, SCFH	56,140	56,260	55,090	54,130	54,760	54,830	54,650	54,830	54,900
Char Lift, SCFH	10,120	10,120	1,100	9,970	9,940	9,970	9,990	9,940	9,950
Air to Ring, SCFH	48,220	50,340	54,370	60,000	63,000	70,730	73,250	71,840	72,940
Recycle to Ring, SCFH	21,090	21,100	20,660	20,490	15,550	10,380	0	0	0
Purges									
Recycle, SCFH	4,480	2,250	2,070	2,450	2,540	2,440	3,160	2,150	2,090
Nitrogen, SCFH	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850
Inert, SCFH	0	100	130	0	0	150	130	130	130
Total Flow In, SCFH	141,900	142,060	144,270	148,890	147,640	150,350	143,030	140,740	141,860
Vent Rate, SCFH	58,890	60,530	66,810	77,650	85,270	98,440	95,740	95,980	102,990
Bed Conditions									
Inlet Velocity, fps	2.53	2.57	2.61	2.70	2.68	2.73	2.58	2.56	2.58
Bed Density, lb/ft^3[4]	91	96	89	84	77	76	73	79	68
Average Bed Temperature, ^oF	1850	1840	1840	1840	1850	1850	1850	1850	1850
Overhead Gas Analysis, Dry Mol %									
O_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	2.87	4.35	3.16	1.07	3.06	3.54	2.6	4.56	2.87
CO_2	17.95	17.15	21.64	25.03	25.03	25.46	27.63	25.46	27.63
N_2	79.17	78.50	75.2	73.9	71.91	71.0	69.77	69.99	69.50

[1] Determined by lift line pressure drop
[2] Determined by weigh scale
[3] Determined by orifice flow measurements
[4] Density determined by differential pressure
[5] Determined by feeder rpm: dead-burned dolomite, 360 X RPM; limestone, 281 X RPM; auxiliary fuel, 345 X RPM

Table 35-2. REGENERATOR DATA FOR RUN 35 (Sheet 1 of 2)

Date	← 4/21/76 →			← 4/22/76 →			← 4/23/76 →		
Time	0700	1500	2300	0700	1500	2300	0700	1500	2300
Solids									
Acceptor Feedstock	← Minnekahta Limestone →								
Acceptor Makeup, lb/hr[5]	560	560	560	560	560	560	560	560	560
Acceptor Circulation, lb/hr[1]	6,100	5,240	3,790	4,370	6,690	4,380	6,120	7,600	8,200
Ash and Attrited Acceptor, lb/hr[2]	106	76	90	94	116	122	121	119	
Acceptor Withdrawal, lb/hr[2]	285	390	515	375	255	205	215	250	240
Auxiliary Char Feed, lb/hr[5]	370	180	220	150	130	330	180	240	90
Gas Flows[3]									
Acceptor Lift, SCFH	55,040	54,730	54,630	54,650	55,010	54,410	54,490	54,450	54,740
Char Lift, SCFH	9,940	9,930	10,040	9,970	9,950	10,030	10,050	10,030	10,020
Air to Ring, SCFH	72,080	72,860	72,700	70,490	73,330	74,110	75,290	79,690	81,130
Recycle to Ring, SCFH	0	0	0	0	0	0	0	0	0
Purges									
Recycle, SCFH	2,190	2,140	2,910	2,280	2,420	2,330	2,430	4,370	2,420
Nitrogen, SCFH	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850
Inert, SCFH	0	0	520	520	360	360	130	0	250
Total Flow In, SCFH	141,100	141,510	142,650	139,760	142,920	143,090	144,240	150,390	150,410
Vent Rate, SCFH	94,840	98,760	100,230	97,010	103,440	101,140	101,970	106,910	107,530
Bed Conditions									
Inlet Velocity, fps	2.56	2.57	2.58	2.53	2.57	2.60	2.61	2.70	2.7
Bed Density, lb/ft^3[4]	67	66	67	65	64	62	58	60	60
Average Bed Temperature, °F	1840	1840	1860	1850	1830	1850	1850	1850	1830
Overhead Gas Analysis, Dry Mol %									
O_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	1.98	2.15	3.54	1.64	2.97	3.25	2.42	3.25	1.72
CO_2	28.07	27.63	28.07	27.63	22.06	27.63	28.51	28.51	29.40
N_2	69.95	70.22	68.39	70.73	74.98	69.12	69.07	68.74	68.88

[1] Determined by lift line pressure drop
[2] Determined by weigh scale
[3] Determined by orifice flow measurements
[4] Density determined by differential pressure
[5] Determined by feeder rpm: dead-burned dolomite, 360 X RPM; limestone, 281 X RPM; auxiliary fuel, 345 X RPM

Table 35-2. REGENERATOR DATA FOR RUN 35 (Sheet 2 of 2)

	Glenharold Lignite	Husky Char
Mesh Size, Wt %		
8		
10		
14		
20	19.0	23.6
28		
35		
48	58.8	51.4
65		
100	18.2	15.5
200		
Pan	4.0	9.5
Ultimate Analysis, Wt %		
Moisture	3.93	1.83
C	65.89	74.62
H	4.54	2.13
N	0.62	0.92
S	0.87	1.78
Ash + SO_3	5.91	12.02
Elemental Analysis, Wt %		
SiO_2	31.0	34.52
SO_3	19.15	21.39
Na_2O	5.81	3.41
CaO	22.80	17.26
MgO	5.90	5.53
K_2O	0.62	0.55
P_2O_5	0.06	0.04
Al_2O_3	7.23	8.20
Fe_2O_3	6.18	7.71
TiO_2	0.22	0.18

Table 35-3. COAL FEEDSTOCK COMPOSITES FOR RUN 35

	Minnekahta Limestone	Dead-Burned Dolomite
Mesh Size, Wt %		
4		
6		0.2
8		0.6
9	58.9	0.9
10		11.5
12	38.6	41.9
14		29.2
16		12.4
20	2.3	3.2
24		0.2
28	0.1	Tr
Pan	0.1	Tr
% Calcine Change	-43.0	-0.5
Elemental Analysis, Wt %		
SiO_2	3.39	1.64
SO_3	0.30	0.10
Na_2O	0.10	0.03
CaO	93.72	55.88
MgO	0.82	39.23
K_2O	0.07	0.01
P_2O_5	0.03	0.01
Al_2O_3	0.87	1.04
Fe_2O_3	0.39	0.51
TiO_2	Tr	0.05
S=		0.10

Table 35-4. ACCEPTOR FEEDSTOCK COMPOSITES FOR RUN 35

Date	4/19	4/20	4/21	4/22	4/23
Time	0800	0800	0800	0800	0800
Mesh Size, Wt %					
6		0.4	1.0	0.6	0.4
8	4.5	11.8	16.3	16.7	19.5
9	5.3	12.1	17.5	18.8	24.2
10	11.4	18.1	18.6	21.9	23.0
12	33.8	23.3	16.6	15.0	12.4
14	28.5	18.4	13.3	10.8	8.0
16	10.6	8.4	6.7	5.2	4.0
20	3.4	3.9	4.1	3.6	2.5
24	0.8	1.3	2.1	2.8	2.2
28	0.1	0.4	0.9	0.9	0.8
Pan	1.6	1.9	3.0	3.9	3.0
% Calcine Weight Change	-1.3	-8.4	-1.5	-1.3	-0.4
Elemental Analysis, Wt %					
SiO_2	4.07	6.31	8.32	11.25	9.18
SO_3	1.05	2.35	2.57	2.42	3.20
Na_2O	0.19	0.47	0.60	0.80	0.62
CaO	64.03	65.08	75.18	72.27	78.04
MgO	27.30	22.20	8.25	7.42	4.30
K_2O	0.03	0.28	0.07	0.08	0.18
P_2O_5	Tr	Tr	0.01	0.01	0.01
Al_2O_3	1.27	2.11	3.56	3.63	2.70
Fe_2O_3	1.21	1.37	1.37	1.81	1.87
TiO_2	0.05	0.09	0.08	0.11	0.09
S=	0.36	0.66	0.80	0.94	0.58

Table 35-5. CALCINED ACCEPTOR RETURN FOR RUN 35

Date	4/18	4/19	4/20	4/21	4/22	4/23
Time	0800	0800	0800	0800	0800	0800
Mesh Size, Wt %						
6			0.3	0.6	0.8	0.8
8	0.5	3.6	10.1	14.4	16.9	21.6
9	0.4	3.9	11.0	15.8	20.5	23.0
10	8.9	8.0	16.8	19.1	21.0	21.4
12	35.2	29.3	23.9	17.8	15.0	11.7
14	32.4	30.6	20.1	14.5	10.5	8.0
16	15.8	15.5	10.6	6.9	5.2	3.8
20	4.7	6.0	4.1	5.2	4.1	3.2
24	1.0	1.6	1.7	2.7	2.5	2.5
28	0.3	0.5	0.3	0.7	0.9	1.3
Pan	0.7	1.1	1.0	2.5	2.5	2.7
Bulk Density, lb/ft^3		160	154	136	125	125
Activity		0.13	0.16	0.21	0.19	0.23
% Calcine Weight Change	-0.9	-4.1	-6.8	-11.4	-10.1	-12.1
Elemental Analysis, Wt %						
SiO_2	4.91	3.61	6.30	9.19	10.60	9.82
SO_3	1.37	1.07	1.73	2.83	2.44	2.87
Na_2O	0.17	0.20	0.33	0.63	0.63	0.63
CaO	51.34	62.61	65.58	73.53	70.98	78.32
MgO	37.40	29.89	23.92	10.03	9.94	3.48
K_2O	0.02	0.02	0.19	0.08	0.05	0.04
P_2O_3	0.01	Tr	0.01	0.01	0.02	0.01
Al_2O_3	1.70	1.33	1.86	1.47	2.83	2.98
Fe_2O_3	1.98	1.50	1.36	1.68	1.79	1.81
TiO_2	0.20	0.07	0.07	0.10	0.11	0.08
S=		0.20	0.72	0.92	1.00	0.99

Table 35-6. RECARBONATED ACCEPTOR RETURN FOR RUN 35

Date	4/21/76		4/22/76		4/22/76		4/23/76		4/23/76		4/23/76	
Time	2340		0230		1830		0130		0930		1700	
	As Rec	Accep	As Rec	Accep	As Rec	Accep	As Rec	Accep	As Rec	Accep	As Rec	Accep
Mesh Size, Wt %												
8	15.2	22.5	11.8	12.9	14.2	32.5	18.3	21.8	18.3	25.1	11.3	21.4
9		19.6		16.5		25.2		22.7		28.6		18.9
10	24.3		22.8		23.4		30.0		34.1		18.5	
12		28.5		28.9		26.0		26.1		27.8		18.9
14	20.0	6.6	24.0	7.7	21.6	4.1	16.1	4.7	22.4	3.9	13.4	4.1
20	9.2	9.5	9.9	12.4	11.1	5.7	7.0	7.6	6.3	5.5	7.7	8.7
28	8.4	6.1	8.2	8.8	9.9	3.3	7.3	6.6	5.2	3.5	10.2	8.7
35	8.4		7.5		7.0		7.5		4.5		12.2	
48	8.3		8.4		6.8		7.8		5.3		14.1	
65	4.0	7.2	4.3	12.9	3.6	3.3	3.9	10.4	2.3	5.5	7.4	18.9
80		Tr		Tr		Tr		Tr		Tr		0.4
100	1.8		2.6		2.1		1.9		1.2		4.1	
200	0.5		0.5		0.4		0.2		0.2		1.0	
Pan	Tr	Tr	Tr	0.0	Tr	Tr	Tr	0.0	Tr	Tr	Tr	Tr
% Acceptor	79.0		70.4		58.2		75.7		83.4		63.4	
% Ash in Char	8.82		11.49		9.46		11.27		6.73		14.77	
Elemental Analysis, Wt %												
SiO_2	17.10										18.56	
SO_3	15.80										13.88	
Na_2O	7.05										7.87	

Table 35-7. PURGED GASIFIER BED MATERIAL FOR RUN 35

Date	4/18/76		4/19/76		4/20/76		4/21/76		4/22/76		4/23/76	
Time	0400		1230		0410		2000		1200		1200	
	As Rec	Accep	As Rec	Accep	As Rec	Accep	As Rec	Accep	As Rec	Accep	As Rec	Accep
Mesh Size, Wt %												
8	0.6	1.6	4.4	5.4	6.8	14.5	9.8	16.3	9.6	21.8	10.6	21.3
9		1.6		5.4		13.7		14.6		14.8		17.6
10	3.1		7.4		13.9		16.7		14.7		19.2	
12		45.1		35.8		32.2		27.0		23.8		22.2
14	29.2	16.4	30.3	15.5	27.0	8.9	19.1	7.3	15.6	5.9	13.4	4.6
20	14.4	16.4	15.1	14.9	11.4	10.5	8.8	10.7	8.2	9.9	7.1	8.3
28	9.8	4.1	8.5	4.7	7.8	5.6	7.9	8.4	8.8	8.9	9.0	8.3
35	11.6		9.4		9.4		8.7		9.9		10.3	
48	13.7		11.1		10.7		11.0		12.7		12.5	
65	8.9	13.1	6.9	17.6	7.0	13.7	7.4	15.7	8.4	14.8	7.5	17.6
80		0.8		0.7		Tr		Tr		Tr		Tr
100	5.6		4.4		4.1		5.6		6.5		5.6	
200	2.6		2.0		1.7		3.3		3.5		3.0	
Pan	0.6	0.8	0.5	Tr	Tr	0.8	1.8	Tr	2.2	Tr	1.7	Tr
% Acceptor	50.6		64.9		70.1		62.9		51.6		60.4	
% Ash in Char	25.15		26.11		21.12		14.94		12.79		13.7	
Elemental Analysis, Wt %												
SiO_2	24.35				22.09		17.40		14.52		14.35	
SO_3	15.95				13.48		13.61		11.77		12.89	
Na_2O	5.20				5.85		7.75		6.21		6.40	

Table 35-8. REGENERATOR FUEL CHAR FOR RUN 35

Date	4/17/76	4/18/76	4/19/76	4/20/71	4/21/76	4/22/76	4/23/76	
Sample	15175	15225	15278	15336	15396	15481	15580	Average
Mesh Size, Wt. %								
+35	1.5	0	0	0	0	0	0	0.2
48	1.5	0	0.2	0	0	0.1	0.1	0.3
65	2.7	4.3	3.7	1.0	1.4	1.2	1.5	2.3
100	14.9	21.7	20.0	12.9	12.0	10.2	10.4	14.6
200	41.0	44.0	36.4	36.1	33.8	26.9	30.5	35.5
325	23.6	24.3	30.8	37.4	29.3	22.5	15.4	26.2
Pan	15.0	5.7	8.9	12.5	23.5	39.1	42.1	21.0
Ultimate Analysis, Wt %								
C	63.0	62.7	59.5	59.4	67.5	70.5	62.2	63.54
H	1.8	1.0	0.8	0.9	0.9	0.9	1.0	1.04
N								
S	0.99	1.26	1.10	0.83	0.80	0.55	0.97	0.93
Ash	29.85	31.37	29.55	34.71	25.59	22.35	29.61	29.00
Elemental Analysis, Wt %								
SiO_2	32.50	31.64	27.98	21.21	23.24	20.54	19.47	25.23
SO_3	7.86	9.32	8.65	6.45	7.03	6.10	7.88	7.61
Na_2O	4.50	5.22	7.45	6.47	6.42	10.14	7.23	6.78
CaO	29.95	29.71	28.43	30.04	35.88	38.07	44.55	33.80
MgO	9.78	10.10	9.38	13.33	7.89	7.24	5.63	9.05
K_2O	0.54	0.60	0.58	0.89	0.93	1.12	0.95	0.80
P_2O_5	0.04	0.03	0.04	0.06	0.04	0.05	0.05	0.04
Al_2O_3	6.21	5.63	7.92	11.69	8.75	8.21	4.98	7.63
Fe_2O_3	6.53	6.36	8.53	8.39	7.63	8.14	6.90	6.41
TiO_2	0.44	0.37	0.39	0.45	0.42	0.41	0.32	0.40

Table 35-9. GASIFIER CYCLONE CHAR FOR RUN 35

Date	4/20/76	4/21/76	4/22/76	4/23/76	
Sample	15360	15397	15486	15534	Average
Mesh Size, Wt %					
+35	0.5	3.0	0.9	0.6	1.3
48	3.4	6.8	4.6	4.5	4.8
65	8.5	13.4	9.0	8.9	10.0
100	16.1	19.8	14.7	13.6	16.1
200	27.5	28.9	23.7	27.7	27.0
325	17.6	12.2	20.5	21.0	17.8
Pan	26.3	15.9	26.7	23.7	23.2
Elemental Analysis, Wt %					
SiO_2	20.80	22.03	21.10	20.99	21.23
SO_3	9.82	6.56	9.43	8.79	8.65
Na_2O	3.28	4.37	4.52	3.23	3.85
CaO	50.10	52.33	52.14	54.07	52.14
MgO	3.67	5.27	3.61	3.61	4.04
K_2O	0.41	0.48	0.42	0.40	0.43
P_2O_5	0.04	0.02	0.05	0.01	0.03
Al_2O_3	7.10	6.54	5.77	5.89	6.33
Fe_2O_3	2.98	2.74	2.61	2.70	2.76
TiO_2	0.25	0.26	0.24	0.26	0.25
MnO	0.05	0.04	0.03	0.03	0.04

Table 35-10. REGENERATOR CYCLONE ASH FOR RUN 35

Date	4/17/76	4/19/76	4/20/76	4/22/76	4/23/76
Sample	15189	15294	15352	15487	15543
Mesh Size, Wt %					
+8	7.3	0.9	6.9	41.8	23.6
9	0.5	1.1	9.9	21.9	25.6
10	6.7	9.6	16.6	13.7	22.4
12	33.9	37.2	26.1	7.4	10.4
14	31.3	31.2	22.4	5.3	6.5
16	14.1	13.5	10.3	3.1	3.7
20	4.1	4.4	4.1	2.3	2.2
24	1.0	1.1	1.6	1.8	2.0
28	0.5	0.3	0.3	0.6	0.4
Pan	0.6	0.6	1.7	2.1	3.2
Elemental Analysis, Wt %					
SiO_2	1.54	3.51	6.22	9.63	9.02
SO_3	0.24	1.12	1.89	2.70	3.21
Na_2O	0.11	0.38	0.49	0.70	0.73
CaO	54.14	63.11	65.11	71.72	78.17
MgO	39.68	28.72	23.40	8.40	3.54
K_2O	0.01	0.02	0.1	0.07	0.04
P_2O_5	0.01	0.02	0.2	0.03	0.02
Al_2O_3	1.58	1.44	2.02	2.99	2.75
Fe_2O_3	1.65	1.68	1.38	1.71	1.84
TiO_2	0.10	0.12	0.11	0.12	0.14

Table 35-11. REGENERATOR PURGED ACCEPTOR FOR RUN 35

Date	4/17/76	4/18/76	4/19/76	4/20/76	4/21/76	4/22/76	4/23/76
Sample	15223	15272	15330	15402	15470	15532	15600
Mesh Size, Wt %							
+35							
48							
65	3.8	43.8	32.7	3.7	0.0	0.0	0.6
100	27.1	24.6	19.0	34.6	16.0	22.6	4.2
200							
325	53.3	29.6	40.0	58.1	84.0	76.4	93.2
Pan	15.8	2.0	8.4	3.7	0.0	1.0	2.1
Ultimate Analysis, Wt %							
C	54.5	44.3	48.8	69.7	75.2	74.4	72.3
H	1.1	0.7	0.7	0.9	1.1	1.0	1.0
N							
S	0.78	1.06	0.86	0.68	0.9	0.85	0.62
Ash	32.39	43.63	36.89	18.21	16.23	16.59	16.10
Elemental Analysis, Wt %							
SiO_2	29.68	28.94	28.42	22.99	21.59	20.10	19.24
SO_3	6.29	6.58	6.32	9.00	10.99	11.21	10.68
Na_2O	3.78	2.79	2.62	2.82	3.18	2.96	3.28
CaO	29.67	29.92	30.16	35.65	36.59	38.95	36.66
MgO	4.87	4.89	6.05	4.58	3.29	3.18	3.22
K_2O	0.48	0.28	0.35	0.38	0.58	0.59	0.66
P_2O_5	0.10	0.36	0.37	0.39	0.40	0.41	0.47
Al_2O_3	15.44	15.59	14.15	11.92	11.86	12.14	10.89
Fe_2O_3	7.50	9.03	11.06	9.92	9.88	9.93	10.38
TiO_2	0.44	0.39	0.41	0.48	0.67	0.65	0.59

Table 35-12. GASIFIER CHAR TO ORGANIC POND DAILY COMPOSITES FOR RUN 35

	Temperature, °F
Gasifier	
Lignite Feed	330
Boot Heater Outlet	1450
Boot Inlet Gas	1440
Side Flow Heater Outlet	1480
Regenerator	
Air Heater Outlet	800
Air Inlet to Regenerator	840
Acceptor Lift Gas Heater Outlet	1400
Lift Gas Temperature at Engager Pot	1340
Char Lift Gas Heater Outlet	800
Char Lift Station Temperature	770
Char Disengager Pot Temperature	590

Table 35-13. AVERAGE PREHEAT TEMPERATURES FOR RUN 35

Date				4/20/76		← 4/21/76 →			← 4/22/76 →			← 4/23/76 →		
Time				1052	1857	0300	1100	1900	0305	1500	2000	0300	1100	1645
dPR-*	Chart	Zero	Range In. W.C.											
2030	-10/10	9.0	554.0	0.5	0.8	0.6	0.6	0.6	0.6	0.8	0.8	1.0	1.0	2.0
2089	0/100	4.2	25	12	22	11	2	9	5	16	4	55	8	29
2088	0/100	3.0	168.7	44	39	43	38	40	31	34	33	34	34	32
2087	0/100	3.0	43.7	92	77	84	97	80	71	72	73	68	71	65
2094	0/100	3.0	53.9	85	80	90	86	88	75	68	78	71	74	67
2093	0/100	3.0	115.4	46	42	46	48	43	37	36	39	36	37	33
2001	0/100	3.0	126.2	28	24	28	29	27	21	21	23	20	21	18
2002	0/100	3.0	57.1	40	39	40	35	37	35	35	34	35	35	33
2083	0/100	3.0	57.7	53	53	52	49	52	49	48	49	48	48	44
2019	0/100	4.2	300.0	22	25	13	16	18	30	21	21	16	22	20
2037	-10/10	9.0	40.0	-2.5	-2.2	-2.8	-2.8	-3.2	-3.8	-3.6	-4.0	-3.8	-3.8	-3.8
2021	0/100	4.2	50.0	62	50	55	43	50	46	52	45	50	54	65
2022	0/100	4.8	25.0	45	36	35	30	35	30	40	35	36	37	45
2073	0/100	3.0	150.0	32	31	31	30	30	29	29	29	27	28	27
2074	0/100	3.0	180.0	50	51	50	51	52	49	46	48	46	46	44
2075	0/100	3.0	180.0	56	54	51	51	51	50	46	48	46	45	46
2076	0/100	3.0	144.0	43	41	37	38	42	39	36	35	35	35	35
2077	0/100	3.0	144.0	16	14	11	12	21	13	10	10	7	9	10
2024	0/100	4.2	98.6	23	26	24	25	23	23	25	25	25	24	30
2025	0/100	4.2	300.0	4	8	7	5	5	6	11	12	11	10	16
2026	-10/10	9.0	40.0	-2.4	-2.2	-2.4	-2.4	-2.2	-2.4	-2.2	-2.4	-2.4	-2.4	-2.4
2102	0/100	4.2	100.0	74	69	75	62	70	0	42	44	45	36	11
2020	0/100	4.2	300.0	73	72	67	75	73	93	69	70	60	71	66
2036	-10/10	9.0	20.0	-1	-1.3	-1	-1	-1	-1	-1	-2	-2	-2	-2
2028	0/100	4.8	50.0	84	71	76	78	82	60	71	58	60	63	64
2080	-2/2	9.0	40.0	89	85	86	86	89	79	82	76	76	77	75
	Location*							Pressure, In. W.C.**						
	1			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2			78.1	69.3	74.1	64.8	71.8	54.0	60.8	55.3	71.8	53.5	62.0
	3			223.0	199.8	220.7	215.0	211.6	174.0	176.7	179.5	186.2	177.2	167.7
	4			315.3	286.3	314.1	303.4	301.7	252.5	255.0	259.4	262.1	251.6	236.5
	5			354.1	334.4	325.2	323.6	328.5	316.7	291.1	295.2	282.3	293.4	268.7
	6			348.9	329.8	319.3	317.8	321.8	308.7	283.6	286.9	274.5	285.6	260.9
	7			304.9	293.8	281.9	286.7	286.7	276.4	246.2	253.6	238.5	247.5	215.0
	8			257.2	247.6	236.6	242.0	242.7	233.5	203.6	210.4	198.2	205.7	174.1
	9			6.1	-9.0	-3.9	3.0	2.7	0.0	-17.2	-19.5	-17.1	-12.8	-37.2
	10			-17.9	-31.0	-21.3	-15.5	-27.8	-19.8	-33.0	-35.6	-28.4	-27.3	-52.6
	11			4.9	4.3	4.7	4.8	4.6	4.9	4.4	4.7	4.9	4.8	4.9
	12			146.9	133.1	142.3	121.8	135.4	51.0	100.0	94.9	112.4	90.4	69.7
	13			325.5	308.9	300.4	305.9	310.8	285.5	262.7	264.6	253.4	262.9	230.3
	14			320.7	302.6	295.7	301.1	306.1	280.7	257.9	255.0	243.7	253.4	220.5
	15			273.0	261.7	251.4	256.6	258.8	245.3	216.6	220.8	208.6	216.6	183.9

*Refer to Figure 1.
**Static pressure at Location 1 is 150 psig.
Pressures given are differential pressures from Location 1.

Table 35-14. PRESSURE BALANCE TESTS FOR RUN 35

	Gasifier				Regenerator			
	Ring "Ear"	Bubble Cap	Bubble Cap Inclusions	Behind Ring	Middle Of Wall	← Wall	Bottom Middle	→ Surface
% Muffle Change	-5.9	-4.1	-25.9	-25.2	-0.2	-4.9	-0.03	-0.65
SiO_2	45.89	44.91	9.19	12.21	34.21	13.00	51.35	33.22
SO_3	0.30	5.27	4.26	4.18	8.21	6.81	9.52	10.59
Na_2O	15.04	12.37	0.77	0.71	2.39	0.54	1.23	0.90
CaO	21.80	22.38	74.22	72.93	27.88	53.34	27.43	43.86
MgO	3.06	3.64	4.83	3.30	15.32	22.14	3.33	3.78
K_2O	0.82	0.69	0.07	0.05	0.38	0.10	0.13	0.10
P_2O_5	0.02	0.13	0.02	0.03	0.01	0.02	0.03	0.04
Al_2O_3	9.91	8.64	3.36	3.55	6.84	3.00	5.88	5.06
Fe_2O_3	3.13	2.98	2.01	1.96	5.28	1.40	1.39	2.39
TiO_2	0.29	0.25	0.14	0.16	0.24	0.12	0.11	0.18
MnO	0.025	0.030	0.021	0.019	0.038	0.033	0.016	0.028

Table 35-15. GASIFIER AND REGENERATOR DEPOSITS FOR RUN 35

RUN 36

MAY 6 TO MAY 13, 1976

CO_2 ACCEPTOR PROCESS GASIFICATION

PILOT PLANT

RAPID CITY, SOUTH DAKOTA

1 SUMMARY

Run 36 was highlighted by the debut of an imaginative and highly successful startup procedure for Glenharold lignite. The procedure entailed starting up with dead-burned dolomite and Husky char, then switching to Minnekahta limestone and Velva lignite, followed by the addition of Glenharold lignite after all air was removed from the gasifier.

The run was not of sufficient length to achieve steady-state conditions for which heat and material balance data could be obtained. However, the startup was exceptionally smooth and operations had progressed well past the point where all recycle and air had been removed from the gasifier. The Velva lignite used for startup was completely replaced in the gasifier char bed. Approximately 50 percent of the original dead-burned dolomite had been replaced with fresh limestone acceptor prior to shutdown.

During the final day of the run, the plant was buffeted by high winds. The winds which exceeded sixty miles per hour at times caused eight short power dips. The plant operation was only slightly upset by each of these dips. The end of the run was enigmatic. The plant operation was exceptionally smooth when suddenly acceptor circulation through the lower standleg was lost. This caused a boot upset from which it was impossible to recover.

The catalyst in the packed-tube methanator was reduced during this run.

2 TEST DATA

Run 36 data are presented graphically and tabularly at the end of this run report. These figures and tables include:

		Page
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3 SIGNIFICANT EVENTS AND OBSERVATIONS

3.1 TABULAR HISTORY OF RUN 36

3.1.1 Objectives

(1) To demonstrate the workability of a new startup procedure for Glenharold lignite.

(2) To demonstrate plant operability using a medium sodium lignite as a feed.

(3) To achieve a two-day steady-state balance period for which heat and material balance data could be collected.

(4) To reduce the methanation catalyst in the packed-tube reactor and then operate the methanation unit to produce pipeline quality gas.

3.1.2 Accomplishments

(1) Demonstrated the operability of the new startup procedure for Glenharold lignite. The startup went very smoothly and the new procedure in which the air was removed from the gasifier while feeding Velva lignite prevented the formation of the ash-based deposits found in Runs 34B and 35.

(2) Reduced the methanation catalyst.

3.1.3 Termination Cause

The run was ended as a result of a gasifier boot upset which was initiated by the loss of acceptor circulation through the lower stand-leg, CD-204.

3.1.4 Mechanical Problems

(1) The major source of mechanical problems for this run was in the grinding area:

  (a) Problems with the screw conveyor feeding lignite to the surge bin ahead of the roller mill caused the loss of feed to the preheater for a few hours and greatly dropped the level in the preheater. The problem was a loose support bearing which was removed.

  (b) The Redler conveyor stopped a number of times due to a sticking level switch on the lignite surge bin.

(c) The ground coal scalping screen oversize line continually plugged due to the high amount of moisture in the coal.

(2) The water cooler on the unit gas generator developed a tube leak which was repaired. A leak on the water jacket surrounding the firing tube was also discovered but could not be repaired until after the plant shutdown.

(3) During the middle of the run, the acceptor circulation suddenly decreased because a piece of refractory was laying on valve TCV-2030. This upset was not serious, since opening the valve and increasing the balance gas purge yielded enough circulation to maintain the gasifier temperature.

(4) The regenerator gas distributor ring was extensively damaged during the final upset. Part of the ring and twelve bubble caps on the top of the ring were found missing after the shutdown. A new ring was installed.

(5) Some tube metal loss was found in the char lift gas heater, B-204. The condition of the tubes was still acceptable. The maximum process outlet temperature will be reduced to 800°F and the heater will be inspected after each future run.

3.1.5 Process Problems

As the run progressed, high levels of sodium from the Glenharold lignite ash accumulated in the circulating acceptor inventory. Subsequent laboratory tests have demonstrated that the transfer of sodium to the acceptor results in a material which agglomerates easily at the temperature and steam partial pressure normally present in the gasifier boot. The experiments also indicated that the acceptor agglomeration could be avoided by making slight changes in the boot operating conditions.

3.2 CHRONOLOGY OF OPERATIONS

Date	Time	Hours Run	Description
5/6	0910		Started up the unit with air.
"	1130		System pressured up.
"	1200		Started static pressure test to determine leak rate.
"	1745		Finished the static pressure test.
"	1800		J-309, char lift gas, compressor placed on line and all recycle gas compressors started.
"	1900		Lit all process heaters.
"	2330		System at 250°F, started first refractory cure holding period.

Date	Time	Hours Run	Description
5/7	0730		Finished the refractory cure holding period and increasing system temperature.
"	1600		Grinding char for the preheater.
"	1630		System at 700°F, starting second refractory cure holding period.
"	1730		Initiated heater differential pressure tests.
"	1900		Finished the heater differential pressure tests.
"	2030		Finished the second refractory cure holding period, raising system temperatures.
5/8	0406		Started feeding dead-burned dolomite to the gasifier via F-204A, fresh lignite feed lockhopper.
"	0720		Transferred a batch of dead-burned dolomite from the gasifier to the regenerator.
"	0805		Filling the regenerator with dead-burned dolomite via F-206, fresh dolomite feed lockhopper.
"	0935		Finished grinding char for the preheater.
"	1120		Placed the zinc oxide units on line.
"	1445		Initiated solids circulation.
"	1510		Began solids circulation tests.
"	1615		Finished solids circulation tests. Started lift line gas flow tests.
"	1840		Finished lift line gas flow tests. Opened steam flow to gasifier side ring.
"	1917		Feeding char to the gasifier.
"	2305		Initiated air flow to the gasifier side ring.
5/9	0120		Started steam to the gasifier boot flow.
"	0445		Began feeding auxiliary char to the regenerator.
"	0500		Established char transfer.
"	0810	0	Regenerator at 1800°F.
"	1400		Dumping the remaining char in the preheater to to tote bins.
"	1600		Grinding Velva lignite for the preheater.
"	1840		Started feeding lignite to the gasifier.
"	2100		Closed LCV-2002, char transfer valve, manually in order to maintain the gasifier bed level.
"	2200		Increased acceptor circulation.
"	2245		Lost L-156, char conveyor screw, and unable to grind lignite.
"	2300		CO_2 flow started to the gasifier boot.
5/10	0001		Started lignite conservation procedures.
"	0030		L-156 repaired, resumed grinding lignite.
"	0035		Plant returned to normal operating conditions.
"	0230		Initiated air removal procedures.

Date	Time	Hours Run	Description
5/10	1520	31.2	All air out of the gasifier.
"	1700		Redler conveyor sheared a pin stopping lignite grinding.
"	1800		Redler conveyor repaired, grinding lignite again.
"	2015		Recycle gas removed from the gasifier boot flow
"	2100		Redler conveyor sheared a pin.
"	2200		Redler conveyor repaired, started grinding Glenharold lignite to the preheater. NOTE: Experienced several hours of erratic auxiliary char feed which has finally smoothed out.
"	2400		NOTE: Oversize return line in the 100 area prone to plugging.
5/11	2400	63.8	200 area running smoothly. Methanation catalyst being reduced. 100 area operation slowed down by high baghouse differential pressure and plugging of ground coal scalping screen and oversize line.
5/12	0030		Slowly losing calcined acceptor circulation through CD-206.
"	0050		Calcined acceptor circulation reliability improved.
"	1231-1815		Experienced a total of eight power dips due to high winds.
"	1915	83	High gasifier boot level due to inability to transfer acceptor from the gasifier boot, stopped acceptor makeup and acceptor overhead circulation. Intentionally blew away gasifier boot interface by increasing boot gas flow.
5/12	2000		Stopped grinding Glenharold lignite.
"	2230		Shut off auxiliary char feed to the regenerator, preparing to shut down the unit.
5/13	0945		Emptying the preheater of lignite.
"	1000		Starting to depressure the system.

4 RESULTS AND DISCUSSION

4.1 BACKGROUND

The two previous runs (34B and 35) both used Glenharold lignite as a feed. The gasifier deposits found after these two runs indicated that air could not be present in the gasifier while Glenharold lignite was in the char bed. The startup procedure was modified in Run 35 so that all air would be removed from the gasifier while feeding Husky char. However, this did not work very well since the density in the gasifier bed was too high to allow a circulation rate high enough to enable removal of all the air. Thus, for Run 36 a new startup procedure was developed in which all the air was removed while Velva lignite was being fed to the gasifier. The Glenharold lignite was then fed after all air had been removed.

During April it was discovered that catalyst had been lost from the packed-tube methanation reactor during some gas flow tests conducted after Run 33. A momentary flow reversal during the tests blew some of the catalyst backwards out of the tubes. The reactor was repacked and a check valve installed in the line. It was therefore necessary to reduce the catalyst in the beginning of Run 36 so that the methanation unit could be put on stream later in the run.

4.2 ACCOMPLISHMENTS

4.2.1 Major Operational Achievements

The pilot plant operations for Run 36 are summarized below;

SUMMARY OF PLANT OPERATIONS

Hours of Operation

Accep. Cir.	Process Cond.	Fresh Accep.	Without Air In Gasifier	Velva Lignite	Glen-harold Lignite	100% Steam To Boot
100	83	70	52	32	40	47

4.2.2 Plant Data

Tables 36-1 through 36-11 summarize the plant data for Run 36. Operating conditions are shown in Tables 36-1 and 36-2. Feedstock composite analyses are presented in Table 36-3. Effluent and circulated process stream solids analyses are presented in Tables 36-4

through 36-10. Plant pressure balance data is presented in Table 36-11. The calculated pressure balances are included at the bottom of the table. Locations and elevations for the pressure points are shown in Figure 36-1. The raw pressure balance data was corrected as described in the Run 17 report and then forced to converge as described in Run 28 report. Table 36-12 contains the analyses by size fraction of the dust-like deposit found on the walls of the regenerator.

4.2.3 Activity and Intermediate Fines

As shown in Figure 36-2, Run 36 did not last long enough to allow complete change out of the dead-burned dolomite inventory. Figure 36-3, a plot of the intermediate fines inventory in both the gasifier and regenerator, shows that the current acceptor withdrawal system is capable of preventing a buildup of intermediate fines while using Glenharold lignite feed.

4.2.4 Methanation Catalyst Reduction

Prior to reducing the catalyst the methanation unit was purged and then the zinc oxide reactor was heated to about 650°F using the HDS furnace. The packed-tube methanator was then heated to 650°F with hot Dowtherm liquid. Hydrogen was introduced to the system until the concentration reached 50 percent hydrogen by volume. The hydrogen concentration was maintained at this level until the available hydrogen was consumed. The gasifier upset which terminated the run occurred before the methanation unit could be put on line.

4.3 PROBLEMS

4.3.1 Deposits

A massive agglomerated limestone deposit was found in the gasifier boot after shutdown. The deposit, which filled virtually the entire boot, extended all the way above the gas distributor ring and into the transition zone. Above the gasifier bottom head flange the deposit consisted of active acceptor. This part of the deposit was formed during the shutdown. Below this area there was a mixture of active acceptor and dead-burned dolomite. This mixture filled the center of the boot. About three-fourths of the boot circumference was covered with an annular deposit consisting mainly of dead-burned dolomite. This deposit which is frequently found after a shutdown completely covered the outlet to F-213. In front of the entrance to the recarbonated acceptor standleg there was a sizeable void area. The remainder of the boot was filled with a three to five inch layer of dead-burned dolomite directly on top of the boot gas distributor with holes for the boot flow to pass up through.

The formation of the dead-burned dolomite deposits is apparently the result of the gasifier boot design. Since the boot gas distributor is lower in the boot than the inlet to the recarbonated acceptor standleg,

the dead-burned dolomite which first covers the boot distributor cannot be removed and thus stays in the boot for the entire run. Also, since the boot distributor is not "perfect," there are localized areas between the bubble caps or around the edges of the distributor where the dead-burned dolomite is not fluidized. In these areas the dead-burned dolomite will eventually agglomerate. Agglomeration appears to be due to the dolomite surface becoming active so that crystallites between touching particles grow together. Since the gasifier boot seeks a stable geometry, the dead-burned dolomite deposits normally do not cause any apparent operational problems. However, in the future, if it is desired to eliminate these deposits, the boot withdrawal and gas distribution configurations will need to be redesigned.

Since the inlet to the recarbonated acceptor standleg was found to be free of obstructions, the exact cause of the boot upset which resulted in the plant shutdown is unknown at this time. One possible explanation is that sodium, which was transferred from the Glenharold lignite ash to the acceptor as shown in Tables 36-5 and 36-9, accumulated to a level which caused the acceptor to become "sticky" (melt formation) under the gasifier operating conditions. The acceptor in the boot then agglomerated. This supposition was experimentally tested at Conoco Coal's research facilities in Library, Pennsylvania.

A series of tests were conducted during which samples of non-fluidized spent acceptor from Run 36 were individually exposed to conditions of constant temperature and steam partial pressure. The temperature and steam partial pressure ranges studied were 1400° to 1500°F and 9 to 11 atmospheres respectively. These tests clearly showed that acceptor agglomeration was favored by low temperatures and high steam partial pressures. The tests also demonstrated that for the acceptor sodium levels experienced during Run 36 agglomeration could be avoided by maintaining the boot temperature near 1500°F and reducing the steam partial pressure to a maximum of nine atmospheres.

A dusty reddish-orange deposit was found coating the walls near the top of the regenerator. This material was around the entire circumference, about three-quarters of an inch thick. The deposit was very soft and sandy with a composition similar to that of the ash and attrited acceptor recovered in the first cyclone as shown in Tables 36-10 and 36-12. The deposit contained a much larger portion of +65 mesh particles than the material from the cyclone and is seemingly composed of the larger ash and attrited acceptor particles which settled out of the regenerator flue gas. During the run no operational problems could be attributed to the formation of this deposit. This material is not expected to cause problems in future runs due to its extreme friability.

4.3.2 Regenerator Ring Destruction

The regenerator ring was found to be severely damaged during the plant shutdown. The damage was caused by a high CO content in the regenerator recycle gas during the final upset. This high CO was caused by

a rapid removal of air from the regenerator ring coupled with an increase in the rate of auxiliary fuel char addition. It appears that the seal on LCV-2002 was lost for about twenty-five minutes while auxiliary char feed was increased, causing a buildup of char in the char lift line. The seal was then regained, and for about ten minutes the char was blown into the regenerator. By this time much of the air had been removed from the ring. The low air rate and sudden increase in char feed to the regenerator caused the CO level in the regenerator recycle gas to rise drastically, eventually reaching twenty percent. The burning of this high CO gas in the ring yielded temperatures above 2200^{o}F which partially destroyed the ring.

5 FUTURE PLANS

After Run 36 the decision was made to switch the coal feedstock to Rosebud subbituminous coal which has a low sodium content in its ash. This was done to allow time for performing and evaluating the acceptor agglomeration experiments. In the near future, Glenharold lignite will again be used as feedstock. However, during the run the steam partial pressure in the gasifier boot will be maintained at nine atmospheres by adding some recycle gas to the boot flow.

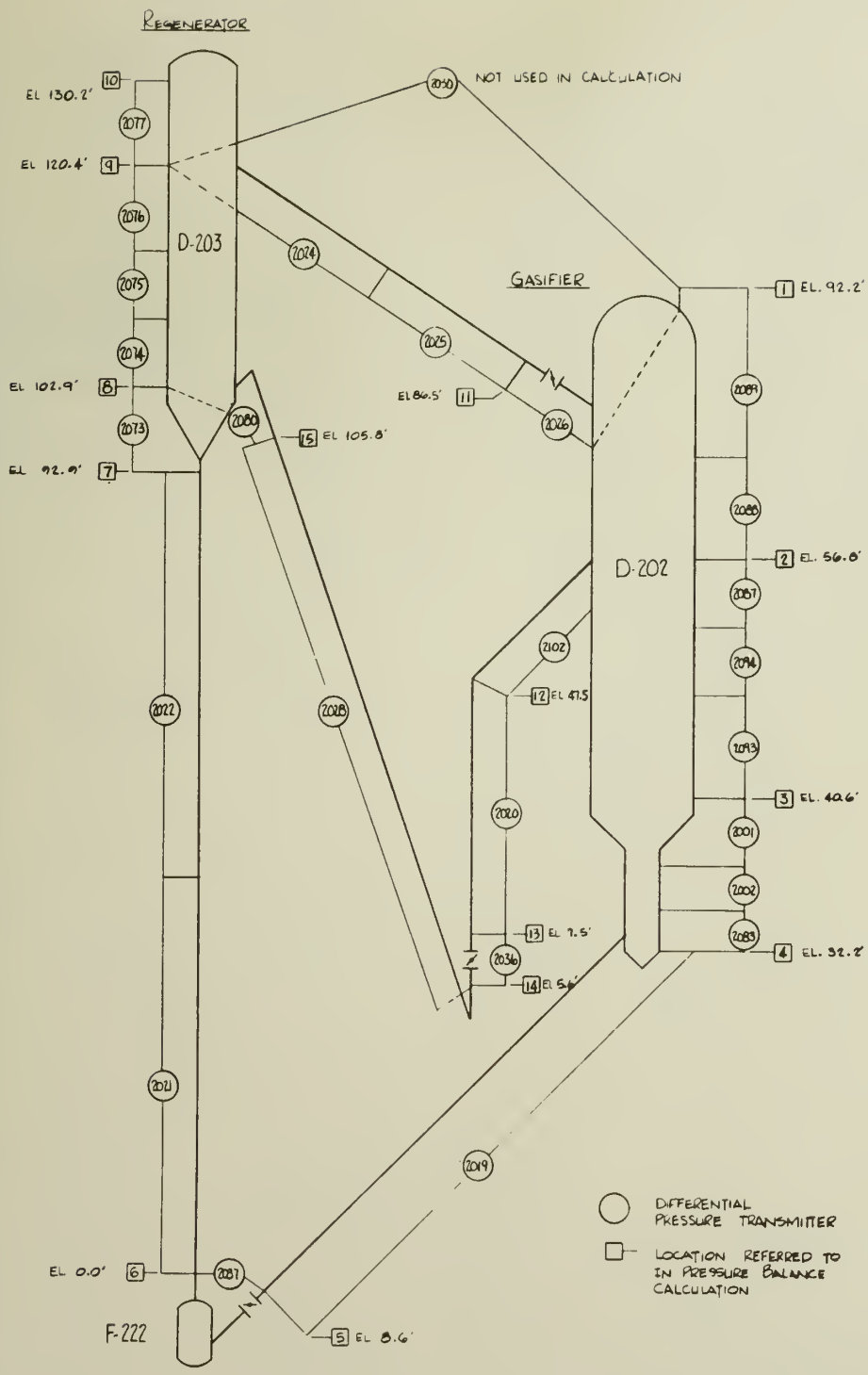

Figure 36-1. DIFFERENTIAL PRESSURE TRANSMITTER LOCATION PRESSURE BALANCE CALCULATION

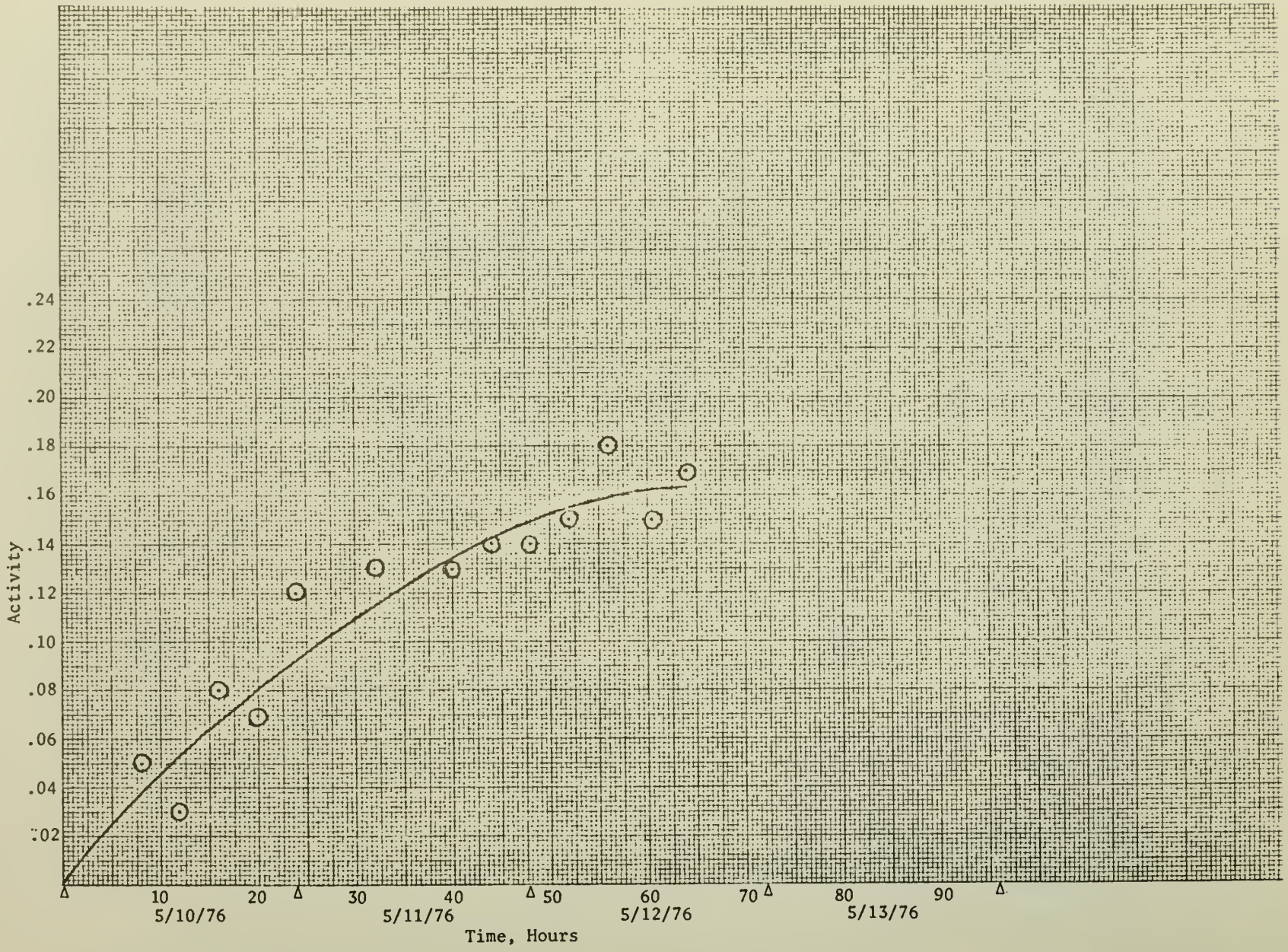

Figure 36-2. ACCEPTOR ACTIVITY FOR RUN 36

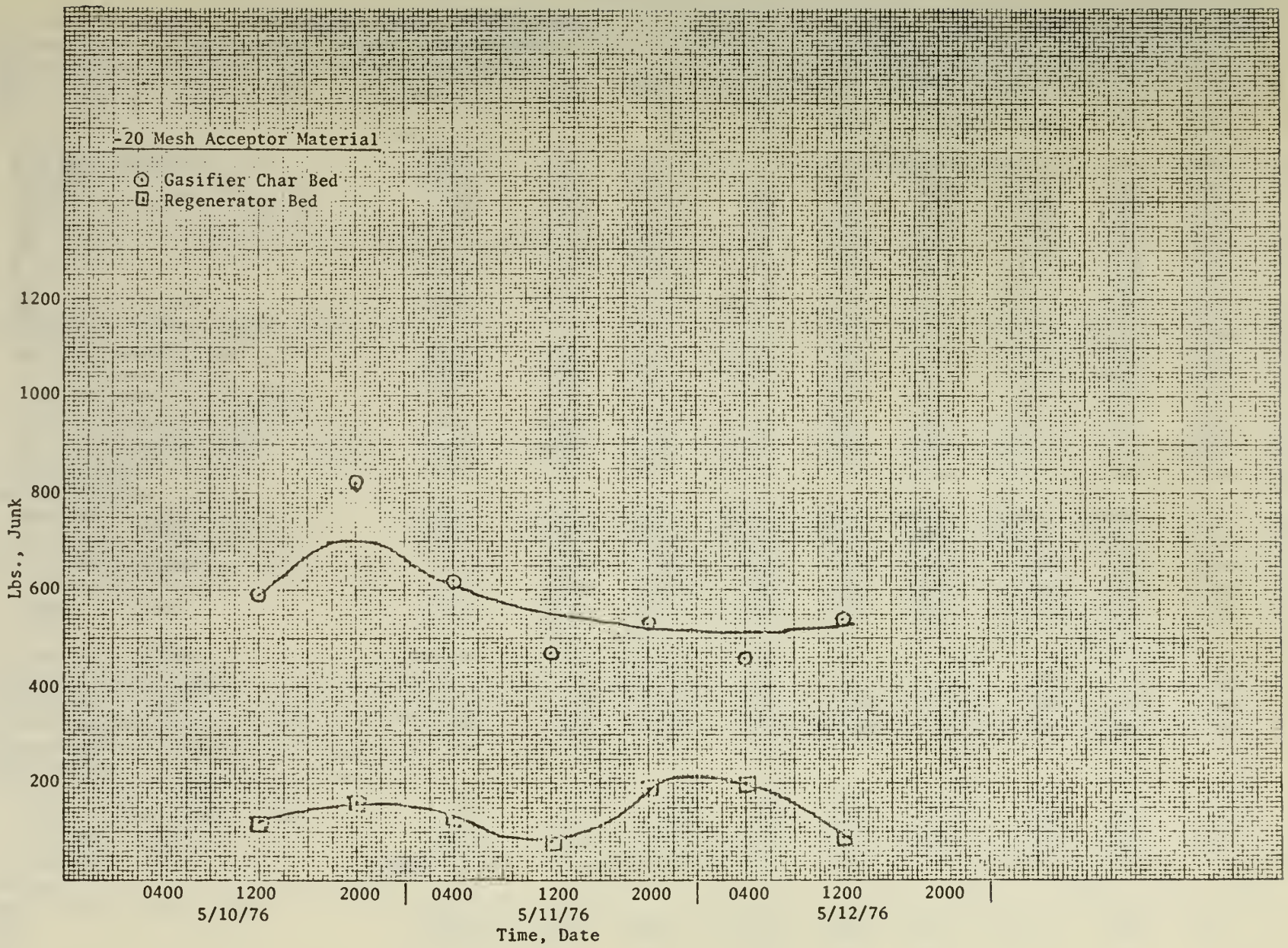

Figure 36-3. INTERMEDIATE FINES INVENTORY FOR RUN 36

Date	← 5/9/76 →		← 5/10/76 →			← 5/11/76 →			5/12/76	
Time	1500	2300	0700	1500	2300	0700	1500	2300	0700	1500
Jacket Steam Make, lb/hr	0	0	0	0	0	0	0	0	0	0
Solids										
Feedstock	Husky Char	← Velva Lignite →			← Glenharold Lignite →					
Feed Rate, lb/hr(1)	940	2,130	2,130	2,130	2,760	2,760	2,760	2,760	2,760	2,760
Cyclone Solids Dump, lb/hr	135	104	125	168	139	139	136	120	120	124
Pond Solids, lb/hr	66	60	60	42	37	45	44	76	122	30
Gas Flows(2)										
Boot (Recycle), SCFH	20,800	21,500	16,300	9,200	0	0	0	0	0	0
Boot (Steam), SCFH	18,500	17,900	22,300	31,600	38,900	39,100	39,900	38,900	40,800	41,800
Boot (CO_2), SCFH	0	0	970	940	980	970	970	990	990	990
Side (Steam), SCFH	30,800	30,300	29,200	20,000	17,100	17,000	17,000	17,100	16,900	17,300
Side (Air), SCFH	18,800	19,300	15,300	2,600	0	0	0	0	0	0
Purges										
Recycle, SCFH	2,500	2,770	2,630	2,940	3,380	3,310	3,410	3,340	3,540	3,550
Inert, SCFH	910	1,160	1,200	980	870	1,190	1,430	1,670	1,750	1,740
Nitrogen, SCFH	1,150	1,190	1,060	1,240	1,240	1,020	1,100	1,150	1,060	1,330
Total Flow In, SCFH	93,500	94,100	89,000	69,500	62,500	62,600	63,800	63,150	65,000	66,700
Vent Rate, SCFH	53,900	63,000	66,300	51,100	50,900	56,300	56,100	56,600	57,100	56,700
Bed Conditions										
Boot Velocity, ft/sec	2.02	1.98	2.04	2.07	1.99	1.98	1.97	1.99	2.08	2.14
Char Bed Velocity Inlet, ft/sec	0.93	0.92	0.89	0.67	0.58	0.58	0.58	0.59	0.60	0.61
Boot Density, lb/ft^3(3)	101	101	96	93	90	86	83	72	68	65
Char Bed Density, lb/ft^3(3)	47	39	35	34	36	35	33	30	28	29
Boot Temperature, °F	1483	1473	1516	1483	1476	1487	1476	1482	1490	1494
Char Bed Temperature, °F	1477	1466	1507	1496	1482	1490	1482	1489	1482	1495
Overhead Gas Compositions, Mol %										
CO	15.9	14.7	16.8	16.0	14.8	15.2	15.4	15.4	14.9	14.9
CO_2	16.4	16.3	13.2	12.8	11.7	10.2	10.7	9.9	9.6	10.2
N_2	30.5	29.9	25.0	9.9	6.8	6.3	4.7	5.6	5.6	7.1
H_2	32.6	33.2	37.7	51.4	55.0	56.3	57.0	56.4	57.6	56.5
CH_4	3.6	6.2	7.1	9.9	12.7	11.8	11.9	11.9	12.1	11.3
PPM H_2S	1500	1500	1000	900	700	850	980	700	650	700
H_2O Mole Fraction(4)	24.7	26.0	23.4	29.4	30.0	27.4	28.1	26.6	26.8	28.1

(1) Determined by feeder rpm - 422 * RPM
(2) Determined by orifice flow meter measurements
(3) Determined by differential pressure measurements
(4) Calculation based on water-gas shift equilibrium

Table 36-1. GASIFIER DATA FOR RUN 36

Date	← 5/9/76 →		← 5/10/76 →			← 5/11/76 →			5/12/76	
Time	1500	2300	0700	1500	2300	0700	1500	2300	0700	1500
Jacket Steam Make, lb/hr	115	110	105	110	110	170	130	205	210	215
Solids	Dead-Burned Dolomite	← 6 X 9 Minnekahta Limestone →								
Acceptor Feedstock										
Acceptor Makeup, lb/hr(1)	360	560	560	560	560	560	560	560	560	560
Acceptor Withdrawal, lb/hr(3)	590	625	465	475	475	510	570	650	620	490
Acceptor Circulation, lb/hr(2)	7,900	12,700	10,600	12,100	12,700	11,200	11,500	10,900	9,700	9,740
Ash and Attrited Acceptor, lb/hr(3)	← Instrument Out of Service →				142	133	98	125	117	84
Auxiliary Fuel Char, lb/hr(1)	86	277	363	311	86	35	52	52	35	104
Gas Flows(4)										
Acceptor Lift, SCFH	55,900	55,700	54,600	54,900	54,500	54,500	54,500	54,600	54,500	55,900
Char Lift, SCFH	10,300	10,100	10,200	10,200	10,000	10,100	10,100	10,300	10,200	10,200
Air Line										
Recycle, SCFH	42,000	18,800	18,400	10,300	0	0	0	0	0	0
Air, SCFH	59,400	65,100	71,200	81,800	85,400	87,200	85,900	87,900	89,400	88,000
Purges										
Recycle, SCFH	3,900	3,060	2,540	2,540	2,730	3,110	2,780	2,910	2,900	2,900
Total Flow In, SCFH	171,500	152,800	156,900	159,700	152,600	154,900	153,300	155,700	157,000	157,000
Vent Rate, SCFH	69,500	78,200	93,300	103,100	111,800	111,200	111,800	115,700	120,700	118,900
Bed Conditions										
Gas Velocity In, ft/sec	3.11	2.79	2.87	2.91	2.81	2.82	2.80	2.85	2.88	2.87
Average Bed Density, lb/ft^3(5)	105	95	92	87	83	80	75	68	63	57
Average Bed Temperature, °F	1831	1842	1834	1824	1850	1835	1838	1842	1849	1839
Overhead Gas Compositions, Mol %										
CO	4.0	2.1	2.2	2.3	2.2	3.3	2.9	2.3	3.1	1.7
CO_2	16.4	18.8	25.0	25.5	26.3	27.2	26.8	28.1	29.4	29.4
N_2	79.6	79.1	72.8	72.2	71.5	69.5	70.4	69.6	67.5	68.9

(1) Determined by feeder rpm: dead-burned dolomite, 360 * rpm; limestone, 281 * rpm; auxiliary fuel, 345 * rpm
(2) Determined by lift line pressure drop measurements
(3) Determined by weigh scale measurements
(4) Determined by orifice flow meter measurements
(5) Determined by pressure tap readings

Table 36-2. REGENERATOR DATA FOR RUN 36

Date: 5/9/76 - 5/12/76

Screen Size, Wt % Tyler Mesh	Acceptor: Dead-Burned Dolomite[1]	Acceptor: Minnekahta Limestone	Screen Size, Wt % Tyler Mesh	Lignite: Husky Char	Lignite: Velva Lignite[2]	Lignite: Glenharold Lignite
+4		0.5	+6		0.8	
4 X 6		35.3	6 X 8		9.8	
6 X 8		28.5	8 X 10		12.6	
8 X 9	0.9	22.6	10 X 14	26.9	21.5	11.7
9 X 10	9.7	10.4	14 X 20		19.0	
10 X 12	26.6	1.2	20 X 28		7.3	
12 X 14	37.3	0.2	28 X 35	53.5	19.3	55.3
14 X 16	20.2	0.4	35 X 48		5.7	
16 X 20	3.8	0.2	48 X 65	14.9	3.4	22.5
20 X 24	0.4	0.1	65 X 100		0.6	
24 X 28	0.9	0.5	100 X 200	4.7		7.5
-28	0.2		-200			
Ultimate Analysis, Wt %						
Moisture				0	2.95	0.49
C				76.5	68.14	63.90
H				2.3	4.65	4.4
S				1.27	0.50	0.75
N				0.73	-	0.89
Ash + SO_3				14.66	6.27	7.57
Elemental Analysis, Wt %						
Sulfide	-	0.01		-	-	-
SiO_2	1.88	3.57		28.22	17.72	24.79
SO_3	0.40	Tr		21.67	12.37	15.88
Na_2O	0.04	0.04		4.69	1.04	5.47
CaO	57.81	94.03		25.99	39.27	28.38
MgO	36.85	1.15		8.75	10.63	8.16
K_2O	0.02	0.05		0.48	0.20	0.62
P_2O_5	0.03	0.03		0.03	0.23	0.07
Al_2O_3	1.48	0.66		7.43	12.93	9.21
Fe_2O_3	1.50	0.38		2.40	5.59	6.14
TiO_2	0.12	0.02		0.26	0.34	0.58

[1] Analysis from Run 28A
[2] Analysis from Run 28B

Table 36-3. FEEDSTOCK COMPOSITES FOR RUN 36

Date	5/9/76	← 5/10/76 →				5/11/76		← 5/12/76 →		
Time	1600	0115	0800	1600	2350	0800	1600	0015	0800	1600
Screen Size, Wt %										
Tyler Mesh										
+4										
4 X 6			1.6			4.1			2.1	
6 X 8			15.5			16.8			20.7	
8 X 9	0.4	0.9	15.8	20.2	19.6	13.3	32.2	38.2	22.3	53.5
9 X 10			23.5			21.0			28.0	
10 X 12	48.2	54.4	16.6	20.8	51.1	21.4	49.9	47.3	15.0	34.6
12 X 14			11.4			15.2			6.8	
14 X 16			6.2			5.4			2.8	
16 X 20	50.5	44.0	3.5	57.5	27.1	1.1	15.5	12.0	1.1	6.9
20 X 24			2.6			1.0			1.5	
24 X 28	0.8	0.5	0.9	0.9	0.8	0.1	0.8	1.1	0.1	2.0
-28	0.1	0.3	2.3	0.6	1.4	0.5	1.6	1.4	0.2	3.1
Elemental Analysis, Wt %										
Sulfide			0.35			0.07				0.33
SiO_2			7.06			4.41				7.38
SO_3			1.93			0.09				2.03
Na_2O			0.68			0.20				0.80
% Calcine Weight Change						-0.6			-0.4	-6.0

Table 36-4. CIRCULATED CALCINED ACCEPTOR FOR RUN 36

Date	5/9/76	← 5/10/76 →			← 5/11/76 →			← 5/12/76 →		
Time	1600	0000	0800	1600	0000	0800	1600	0000	0800	1600
Screen Size, Wt % Tyler Mesh										
+6						0.8			1.6	
6 X 8			1.5			6.3			15.5	
8 X 9	0.2	0.4	1.1	10.0	10.6	9.6	17.2	26.6	15.8	61.0
9 X 10			8.0			20.6			23.5	
10 X 12	40.4	40.5	28.5	45.2	48.4	26.3	47.4	49.9	16.6	28.9
12 X 14			31.5			21.3			11.4	
14 X 16			19.8			8.7			6.2	
16 X 20	57.7	55.9	6.1	41.9	39.1	2.1	27.5	19.5	3.5	6.6
20 X 24			1.4			1.3			2.6	
24 X 28	1.6	1.8	0.3	1.7	1.2	0.5	3.9	2.9	0.9	2.6
-28	0.1	1.3	1.8	1.1	0.3	1.9	3.9	1.3	2.3	0.9
Particle Density, lb/ft^3			187		153	140	132	141	120	110
% Calcine Weight Change			-3.1			-5.6			-10.4	-11.6
Activity			0.05		0.12	0.13	0.13	0.14	0.18	0.17
Elemental Analysis, Wt %										
Sulfide			0.11			0.07			0.39	
SiO_2			2.22			4.51			7.24	
SO_3			0.18			0.16			1.63	
Na_2O			0.10			0.38			1.37	
CaO			58.98			66.73			73.62	
MgO			34.55			24.90			10.68	
K_2O			0.02			0.03			0.06	
P_2O_5			0.01			0.02			0.04	
Al_2O_3			1.21			2.00			2.82	
Fe_2O_3			1.36			1.55			1.74	
TiO_2						0.09			0.09	

Table 36-5. CIRCULATED RECARBONATED ACCEPTOR FOR RUN 36

Date	5/9/76		← 5/10/76 →						← 5/11/76 →						← 5/12/76 →			
Time	2000		0400		1200		2000		0430		1200		2000		0400		1330	
Sample	Mix	Accep.	Mix	Accep.	Mix	Accep.	Mix	Accep.	Mix	Accep.	Mix	Accep.	Mix	Accep.	Mix	Accep.	Mix	Accep.
Screen Size, Wt % Tyler Mesh																		
+8	Tr	2.0		1.8	1.8	3.3	1.8	4.6	2.9	6.7	5.4	12.1	8.4	13.7	7.5	14.9	8.7	27.6
8 X 9		1.0		1.8		6.6		9.2		8.3		12.1		16.3		19.1		23.7
9 X 10	1.2		2.4		4.7		6.4		10.1		16.2		18.7		15.6		15.7	
10 X 12		40.8		42.2		43.3		42.5		44.2		44.0		39.9		34.0		25.0
12 X 14	32.0	22.4	28.7	19.3	30.3	16.4	27.4	16.1	28.5	15.8	26.0	12.1	23.3	8.5	14.9	6.4	11.6	3.9
14 X 20	16.6	23.5	16.8	23.9	14.1	16.4	11.3	14.9	10.9	12.5	7.5	9.9	6.7	7.8	7.0	8.5	7.3	5.3
20 X 28	9.9	2.0	8.5	2.8	7.0	3.3	7.7	3.4	7.0	5.3	6.9	3.3	7.2	4.6	8.8	6.4	9.7	5.3
28 X 35	12.8		11.2		7.2		10.1		9.0		8.1		9.2		9.9		11.4	
35 X 48	13.0		15.5		13.1		13.8		11.9		10.3		11.0		13.7		13.6	
48 X 65	8.3	8.2	9.0	8.3	9.4	10.7	10.6	9.2	9.1	9.2	8.5	6.6	8.1	8.5	9.8	10.6	9.9	9.2
65 X 80				Tr		Tr						Tr		0.7		Tr		Tr
80 X 100	4.8		5.4		6.6		7.5		7.0		6.4		5.3		7.5		7.5	
100 X 200	1.3		0.5		3.5		2.7		2.3		3.4		1.8		3.6		3.6	
-200	0.1		1.9	Tr	2.3	Tr	0.7		1.4		1.5	Tr	0.2		1.8		1.0	Tr
% Acceptor	50.5		59.7		54.0		57.0		56.8		56.4		54.1		(34.8)		49.2	
% Ash/Char	20.2		18.2		15.9		17.7		13.3		10.3		12.8		13.0		11.3	
Elemental Analysis, Wt %																		
SiO_2					21.63						16.32						14.23	
SO_3					3.22						4.93						0.85	
Na_2O					5.59						0.49						7.95	

Table 36-6. GASIFIER CHAR BED MATERIAL FOR RUN 36

Date	5/9/76		← 5/10/76 →			← 5/11/76 →			← 5/12/76 →		
Time	1300	2000	0400	1130	1920	0400	1210	1900	0300	1015	1905
Screen Size, Wt %											
Tyler Mesh											
+35	-	0.2	-	Tr	-	-	Tr	-	-	-	-
35 X 48	0.2	0.2	0.3	1.0	0.2	-	0.1	0.2	0.2	0.3	0.3
48 X 65	0.4	2.2	4.5	7.1	2.4	1.5	1.9	1.5	3.0	2.1	2.1
65 X 100	9.3	20.5	22.2	23.1	13.2	1.3	13.0	9.1	17.3	10.9	12.9
100 X 200	47.0	30.5	14.8	22.0	0.9	8.4	41.5	0.4	0.4	26.7	1.3
200 X 325	19.3	24.5	26.4	30.2	40.6	45.1	16.5	45.0	55.7	16.4	42.6
-325	23.8	22.0	31.8	16.6	42.7	43.7	27.0	43.9	23.8	43.6	40.8
Ultimate Analysis, Wt %											
C	73.5			63.6			63.2		74.0	72.9	73.1
H	1.2			0.8			0.7		1.1	1.0	1.0
N	0.45			0.32			0.29		0.34	-	0.31
Total S	0.7			0.34			0.35		0.42	0.44	0.39
Ash	22.25			29.90			23.3		28.88	21.19	21.51
Elemental Analysis, Wt %											
SiO_2	33.00			19.36			20.34		16.41		15.02
SO_3	7.51			3.92			4.02		4.61		4.36
Na_2O	5.56			4.12			4.20		6.62		8.04
CaO	26.44			40.60			45.36		45.74		47.57
MgO	9.11			11.65			8.90		8.37		7.10
K_2O	0.59			0.56			0.69		1.00		1.08
P_2O_5	0.03			0.08			0.07		0.06		0.05
Al_2O_3	10.85			10.38			9.04		9.20		7.62
Fe_2O_3	5.67			7.63			6.82		7.81		8.67
TiO_2	0.51			0.55			0.60		0.54		0.52

Table 36-7. GASIFIER CHAR TO EXTERNAL CYCLONE FOR RUN 36

Date	5/9/76	5/10/76	5/11/76	5/12/76
Screen Size, Wt %				
Tyler Mesh				
+35	1.5	6.8	1.1	1.8
35 X 48	0.9	12.9	1.1	0.8
48 X 65	2.8	12.4	2.2	2.0
65 X 100	14.8	8.8	6.2	5.8
100 X 200	7.1	8.4	42.4	17.0
200 X 325	54.9	47.2	43.2	56.0
-325	17.9	3.4	3.8	16.8
Ultimate Analysis, Wt %				
C	61.9	61.4	66.8	76.1
H	1.0	1.0	1.0	1.0
N	0.32	0.27	0.31	0.34
Total S	1.01	0.94	0.81	0.70
Ash	31.47	30.08	21.46	16.71
Elemental Analysis, Wt %				
SiO_2	29.26	20.82	21.60	20.90
SO_3	8.90	8.41	8.89	9.82
Na_2O	2.94	3.80	5.48	4.40
CaO	31.37	42.43	37.53	40.34
MgO	5.27	4.67	3.93	3.43
K_2O	0.23	0.44	0.56	0.60
P_2O_5	0.22	0.44	0.37	0.20
Al_2O_3	13.76	13.81	12.47	11.15
Fe_2O_3	5.48	5.72	8.51	9.27
TiO_2	0.55	0.18	0.46	0.43

Table 36-8. GASIFIER CHAR TO ORGANIC POND COMPOSITES FOR RUN 36

Date	← 5/9/76 →			← 5/10/76 →			← 5/11/76 →			← 5/12/76 →		
Time	1230	1850	2330	0730	1430	2115	0420	1010	1915	0000	0800	1230	1700
Screen Size, Wt %													
Tyler Mesh													
+4											0.8		
4 X 6				0.7							12.0		
6 X 8	0.2	0.2	0.3	Tr	1.4	2.9	5.1	8.8	18.5	22.0	16.5	52.8	48.0
8 X 9				8.7							32.4		
9 X 10	39.2	40.4	43.4	32.9	44.5	51.3	51.8	58.7	60.6	57.6	20.3	30.1	41.5
10 X 12				34.1							10.5		
12 X 14				17.7							3.0		
14 X 16	59.7	58.2	55.1	4.5	52.6	43.9	40.3	30.4	19.2	17.7	1.5	12.0	9.1
16 X 20				1.2							1.5		
20 X 24	0.9	1.1	0.9	0.2	1.1	1.2	1.5	1.4	1.2	1.7	0.6	3.9	1.0
24 X 28	Tr	0.1	0.3	0.2	0.3	0.7	1.3	0.8	0.6	0.9	0.9	1.1	0.5
-28													
% Calcine Weight Change	-1.3				0.0			-0.6			+0.2		+0.6
Elemental Analysis, Wt %													
Sulfide	0.01				0.08			0.05			0.23		0.29
SiO_2	0.59				4.91			6.80			8.39		7.08
SO_3	0.02				0.70			0.22			2.03		2.31
Na_2O	0.04				0.45			0.31			0.88		0.98
CaO	57.59				60.25			74.34			76.72		79.48
MgO	36.69				28.56			12.87			6.28		4.61
K_2O	0.01				0.03			0.05			0.09		0.06
P_2O_5	0.01				0.01			0.03			0.03		0.03
Al_2O_3	2.78				2.64			3.28			2.60		0.66
Fe_2O_3	1.14				2.28			1.94			2.32		0.38
TiO_2	0.07				0.18			0.18			0.20		0.02

Table 36-9. ACCEPTOR WITHDRAWAL FOR RUN 36

Date	5/10/76	← 5/11/76 →				← 5/12/76 →			
Time	1820	0145	0900	0930	1730	0145	0845	1000	1740
Hopper	B	B	A	B	B	B	A	B	B
Screen Size, Wt %									
Tyler Mesh									
+35	1.9	4.4	0.4	4.2	5.5	5.5	0.6	2.1	1.6
35 X 48	3.0	4.3	0.9	4.2	4.9	4.4	1.7	3.9	5.0
48 X 65	6.2	8.7	2.0	6.3	7.6	7.0	2.7	6.3	8.4
65 X 100	12.2	14.5	3.8	9.8	11.5	11.2	4.0	10.2	15.2
100 X 200	24.8	20.6	8.2	20.9	23.5	23.3	10.5	21.7	29.7
200 X 325	19.8	28.1	39.4	21.5	13.3	13.3	37.0	15.0	14.0
-325	32.0	19.3	45.2	33.0	33.6	35.2	43.6	40.8	26.1
Ultimate Analysis, Wt %									
C	6.9	6.2	6.4				9.3		7.4[1]
H	0.1	0.1	0.1				0.2		0.1
N	0.03	-	-				0.04		-
Sulfide	1.51	1.58	1.80				3.89		1.43
Total S	1.89	1.75	2.10				2.23		2.88
Ash	96.2	95.2	97.80				98.4		96.5
Elemental Analysis, Wt %									
SiO_2	22.43	19.58	14.30				11.05		18.42
SO_3	8.00	6.02	12.12				16.95		9.76
Na_2O	2.50	3.00	2.49				3.50		0.49
CaO	50.20	52.76	50.94				50.06		55.54
MgO	6.05	8.66	7.09				5.73		5.12
K_2O	0.49	0.51	0.60				0.67		0.40
P_2O_5	0.05	0.06	0.08				0.05		0.05
Al_2O_3	7.82	7.34	7.65				6.81		5.64
Fe_2O_3	2.47	2.67	3.00				3.43		2.94
TiO_2	0.26	0.26	0.30				0.26		0.18

[1] Composite sample

Table 36-10. ASH AND ATTRITED ACCEPTOR COMPOSITES FOR RUN 36

Date				← 5/10/76 →		← 5/11/76 →			← 5/12/76 →	
Time				1900	2300	0300	1330	1710	0300	1150
dPR-*	Chart	Zero	Range In. W.C.							
2030	-10/10	9.0	554.0	4.5	4.5	4.3	3.0	3.4	3.4	1.5
2089	0/100	4.2	25	33	31	31	40	32	39	19
2088	0/100	3.0	168.7	33	34	30	42	30	28	27
2087	0/100	3.0	43.7	65	66	66	61	58	51	58
2094	0/100	3.0	53.9	56	59	58	53	60	53	54
2093	0/100	3.0	115.4	35	37.5	36	33	31	28	29
2001	0/100	3.0	126.2	19	20	19	18	17	15	16
2002	0/100	3.0	57.1	40	40	40	39	37	35	30
2083	0/100	3.0	57.7	61	60	59	55	52	47	43
2019	0/100	4.2	300.0	22	26	24	30	26	22	35
2037	-10/10	9.0	40.0	-1.6	-1.6	-2.0	-1.5	-1.6	-0.4	-1.5
2021	0/100	4.2	50.0	95	94	88	88	86	75	78
2022	0/100	4.8	25.0	63	61	55	55	53	48	50
2073	0/100	3.0	150.0	42	41	40	37	33	30	28
2074	0/100	3.0	180.0	64	63	60	60	51	39	43
2075	0/100	3.0	180.0	62	63	63	60	56	51	46
2076	0/100	3.0	144.0	43	45	43	42	39	36	33
2077	0/100	3.0	144.0	8	18	15	20	20	20	18
2024	0/100	4.2	98.6	46	46	42	38	37	36	27
2025	0/100	4.2	300.0	35	34	32	28	27	26	17
2026	-10/10	9.0	40.0	-2.3	-2.3	-2.2	-2.2	-2.3	-2.3	-5.0
2102	0/100	4.2	100.0	37	37	37	45	49	46	46
2020	0/100	4.2	300.0	59	66	65	65	57	50	63
2036	-10/10	9.0	20.0	-2.0	-2.0	-2.0	-1.5	-0.5	-0.4	-0.4
2028	0/100	4.8	50.0	61	66	66	62	63	55	60
2080	-2/2	9.0	40.0	68	71	71	71	70	68	69
Location*				Pressure, In. W.C.**						
1				0.0	0.0	0.0	0.0	0.0	0.0	0.0
2				64.7	64.1	59.0	77.2	57.2	53.5	47.5
3				171.8	175.5	168.5	178.0	157.5	143.0	140.8
4				260.2	263.9	255.4	260.5	235.1	213.7	206.6
5				300.5	316.5	301.8	326.3	287.7	253.6	286.9
6				297.0	313.1	297.6	323.1	284.3	252.7	283.7
7				235.3	251.6	240.7	266.2	228.6	203.4	231.7
8				175.6	192.7	183.5	213.3	180.9	160.1	190.6
9				-110.5	-104.5	-97.7	-77.1	-74.9	-68.3	-30.0
10				-123.1	-132.1	-120.2	-108.5	-105.6	-100.1	-58.6
11				4.7	4.6	4.5	4.2	4.5	4.3	9.5
12				96.3	96.0	90.7	116.4	100.4	93.8	88.4
13				229.0	249.8	240.8	266.3	228.9	202.5	235.7
14				219.8	240.4	231.5	259.3	226.6	200.6	233.8
15				183.0	201.3	192.2	222.0	189.1	167.4	198.2

*Refer to Figure 1.
**Static pressure at Location 1 is 150 psig.
Pressures given are differential pressures from Location 1.

Table 36-11. PRESSURE BALANCE DATA FOR RUN 36

Tyler Screen Size		+14	14 X 20	20 X 28	28 X 35	35 X 48	48 X 65	65 X 100	-100
Size, Wt %		3.0	0.6	2.4	11.5	23.5	19.6	1.0	38.4
% Weight Change, Muffle	-4.0	-2.0	-3.3	-3.7	-4.0	-3.8	-3.9	-3.8	-4.1
Elemental Analysis, Wt %									
SiO_2	20.00	28.68	27.86	25.98	23.59	24.53	21.45	22.72	16.02
SO_3	11.75	10.75	8.34	8.82	8.74	11.18	11.78	9.92	12.86
Na_2O	3.73	1.56	2.95	3.56	3.93	3.65	3.64	3.45	3.70
CaO	52.23	45.55	50.46	51.50	51.82	49.87	52.10	52.36	53.50
MgO	3.10	8.13	2.98	2.81	2.51	2.31	2.48	2.44	3.72
K_2O	0.35	0.17	0.32	0.37	0.44	0.42	0.44	0.45	0.41
P_2O_5	0.04	0.03	0.05	0.05	0.04	0.04	0.04	0.04	0.04
Al_2O_3	6.02	3.48	5.00	5.02	5.99	5.63	5.72	5.93	6.28
Fe_2O_3	2.11	1.87	1.49	1.48	1.70	1.95	2.24	2.47	3.02
TiO_2	0.28	0.17	0.24	0.29	0.28	0.26	0.26	0.24	0.29

Table 36-12. REGENERATOR DEPOSIT ANALYSIS FOR RUN 36

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